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What is the social cost of injured people in traffic accidents? An assessment for Catalonia

The social cost of injured people in Catalonia

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ABSTRACT

Background: Traffic accidents are an important public health problem worldwide, in terms of mortality, morbidity, and economic burden. The goal of this study is to estimate the social cost of injured people in traffic accidents in Catalonia in the year 2007.

Methods: We performed a cost-of-illness analysis, under the perspective of the healthcare system, the public sector and the society, using a one year time horizon. In Catalonia during 2007 there were a total of 26,063 accidents with victims, which translates into 34,565 non-mortal victims and 521 deaths (35,607 in total). As direct costs, all healthcare costs have been included (primary care, acute hospital care, emergency care, ambulances and transport, long-term care, and specialized care), costs of adaptation to disability, disability benefits, material costs, administrative costs and costs of police, fire-fighters and road assistance. As indirect costs, productivity losses due to hospital and long-term institutionalization have been taken into account, as well as productivity losses from work sick leave, and productivity losses of carers.

Results: From the perspective of the healthcare system, the cost of the injured people in traffic accidents was 31,803,024.03€ in 2007; from the perspective of the public sector it was 134,047,059.27€ (up to 1,463,645,407.13€ in the sensitivity analysis); and 144,043,238.88€ (up to 1,558,926,995.12€ in the sensitivity analysis) from the perspective of the society. The cost per injured person ranged from 3,855.38€ from the perspective of the healthcare system to 17,461.90€ from the perspective of the society (up to 188,983.76€ in the sensitivity analysis).

Conclusions: The importance of the costs of injured people in traffic accidents is an argument more -besides the epidemiological and social impact- to start off preventive policies.

Key words: Cost of illness, injuries, traffic accidents.

INTRODUCTION

Traffic accidents are an important public health problem around the world, in terms of mortality and morbidity^{1,2}. According to the WHO, more than a million people die in the world due to traffic accidents yearly, and between 20 and 50 million people get injured. In Spain, injuries in traffic accidents are the first cause of death for the population up to 39 years, the third for the population of 40 to 59 years old, and the fifth for that of 60 to 69 years old³. Moreover, they are the first cause of potential years of life lost between men, and the second among women^{4,5}.

Catalonia is one of the 17 Autonomous Communities of Spain, with a population of 7,364,078 inhabitants (as in 2007), and an extension of 31,895 km², situated in the northeast of Spain. In Catalonia, there were 26,063 traffic accidents with victims registered during 2007, which translates into 34,565 non-mortal victims and 521 deaths⁶. Even though the number of deaths has diminished during the last 10 years (they were 950 deaths in year 1998), the number of injured people has kept stable.

This issue is in the policy agenda of local, national and supranational administrations. To improve road safety, the White Paper on European Transport Policy established the goal to reduce traffic accidents by 50% between 2001 and 2010⁷. The Road Safety Action Programme describes specific measures related with the behaviour of users, safety of vehicles, and road infrastructures to achieve this goal⁸. European governments, among them that of Catalonia, have started special measures with the same purpose⁹.

A part from their human cost, traffic accidents involve a strong economic cost in terms of lost productivity as well as for the public sector in terms of welfare benefits and specific policies and, in particular, for the healthcare sector including acute and rehabilitation care. The existing estimations -including deaths and injured people- show that the cost of traffic accidents in several Spanish cities and regions were between 147.24€ per capita in Canary Islands in 1997 and 576.47€ per capita in Galicia in 2003^{10,11,12}; estimations for Spain were up to 204.93€ per capita in 2004^{13,14}, and up to tens of billions of Euros in the European Union¹⁵.

The aim of this study is to estimate the social cost of injured people in traffic accidents in Catalonia in the year 2007, using the cost of illness method.

MATERIALS AND METHODS

A cost-of-illness analysis was performed using the prevalence approach, valuing all costs occurred associated with traffic accidents during 2007. For every cost concept, a different number of cases have been used, as well as different data sources of costs, as explained bellow.

Prevalence. In Catalonia during 2007 there were a total of 26,063 accidents with victims, which translates into 34,565 non-mortal victims and 521 deaths (35,607 in total)⁶. The number of acute hospital admissions has been calculated using the external cause code and the type of funding of the admission reported on the registry of minimum basic data of acute hospitals (CMBD-HA, according to the Catalan abbreviation), accounting for 8,249 admissions. According to their severity, 86.5% were slight injuries, and 13.5% correspondent to severely injured people¹⁶.

Perspective of analysis. We used the perspective of analysis of the healthcare system, the public sector, and the society. Under the perspective of the healthcare system only direct healthcare costs have been included: primary care, acute hospital care, emergency care, ambulances and transport, long-term care, and specialized care. Under the perspective of the public sector, disability benefits, police, fire fighters and road assistance costs, and subsidies for temporary and permanent work sick leave have been added to the healthcare costs. Finally, from the perspective of the society, private direct costs associated with adaptation to disability, material costs, administrative costs, and productivity losses of injured people and their carers have been added.

Primary care. It has been assumed that all injured people that have not been admitted to hospital have visited once a primary healthcare professional, and applied the corresponding reimbursement tariff to this number¹⁷ (Table 1).

Acute hospital care. To the total number of acute hospital admissions due to traffic accidents, the reimbursement tariff by hospital complexity was applied¹⁷ (Table 1).

Emergency care. It has been assumed that all acute hospital admissions had a previous visit in the emergency department. Thus, the reimbursement tariff by hospital complexity was applied¹⁷ (Table 1).

Ambulances and transport. It has been assumed that acute hospital admissions corresponding to slightly injured people got to the hospital by ambulance, while those corresponding to severely injured got by helicopter. To these numbers, we applied the corresponding reimbursement tariff (Medical Emergency Service, personal communication) (Table 1).

Long-term care. We obtained the number of episodes of long-term care by typology of service from the registry of minimum basic data of long-term centres (CMBD-SS, according to the Catalan abbreviation). To the total days of stay by typology of service, it was applied the corresponding unitary reimbursement tariff¹⁸ (Table 1).

Specialized care. We assumed that the 86.5% of slightly injured people would have a degree 1 of disability, and that would only need an hour of nursing care per month¹⁶, with its corresponding reimbursement tariff updated to 2007^{19,20}. For the ones severely injured (13.5%) we assumed that they had a degree 2 and 3 of disability, and they would need an

hour of physiotherapy per day, and an hour of nursing care per month, with its corresponding reimbursement tariff updated to 2007^{19,20} (Table 1).

Adaptation to disability. To calculate the costs of adapting to disability, we took into account the annualized investment necessary to adapt a home to a physical disability, technical aids and orthopaedic material, and vehicle adaptation, and applied to those 13.5% severely injured, with its corresponding costs updated to 2007^{19,20} (Table 1).

For technical aids and orthopaedic material, a minimum value in the base case has been used (corresponding to orthopaedic material and less technical help) and a maximum value (orthopaedic material and more technical help) in the sensitivity analysis, with its corresponding costs updated to 2007^{19,20}. Regarding vehicle adaptation, a minimum value was used in the base case (less adaptations) and a maximum value (more adaptations) was used in the sensitivity analysis, with its corresponding cost updated to 2007^{19,20} (Table 1).

Disability benefits. In Catalonia there are several entities that provide disability benefits. Money grants are conceded for specialist treatments (psychomotricity, language rehabilitation, physiotherapy), personal assistance, social support and home care, day care in specialized centres, mobility (management of driving license, vehicle adaptation), specific services (early attention, rehabilitation), technical aids, family respite services, accessibility, tax exemptions, and discounts in transportation. The mean money grant was used in the base case, using the mean maximum value in the sensitivity analysis, updated to 2007, for those severely injured (13.5%)^{16,19,20} (Table 1). Finally, people with disabilities have deductions on taxable income. The mean minimum deduction was used in the base case, and the mean

maximum value was used in the sensitivity analysis, updated to 2007, for those severely injured (13.5%)^{16,19,20} (Table 1).

Material costs. According to insurance data, 25% of the traffic accidents have material costs. Of these, and regardless the type of vehicle, approximately 75% have costs between 600-900€, 4% between 900-1,500€, 2% between 1,500-4,800€ and 1% between 4,800-10,500€; accidents with costs higher than 10,500€ are less than 1%; the rest have costs lower than 600€²¹. Therefore, it has been considered that all accidents with victims in Catalonia would have had material costs, using the cost of 600€ in the base case; in the sensitivity analysis the cost of 900€ has been considered, and 1% of the accidents with a cost of 10,500€ has been added (Table 1).

Administrative costs. It has been considered that there is an additional administrative cost when compensations have to be managed. According to data from insurance companies, administration costs in year 2007 accounted for 10.12% of car insurance premiums²². In a similar way, it has been assumed that administrative costs of managing compensations would be 10.12% of the value of compensations. We applied the mean compensation cost of 342€ for slight body damages, and the mean compensation cost of 5,805€ for severe body damages²³, to the number of people slightly (86.5%) and severely injured (13.5%) in Catalonia in 2007. Then, the 10.12% of the resulting amount was included.

Police, fire fighters and road assistance costs. It has been estimated that the intervention of the police would have a cost of 515.88€ in accidents with severe injured people (13.5%), and a cost of 259.90€ in accidents with slightly injured people (86.5%), updated to 2007^{6,14,20} (Table 1). In a similar way, the intervention of the fire fighters has been estimated to have a

cost of 221.37€ in accidents with severely injured people (13.5%) and a cost of 104.48€ in accidents with slightly injured people (86.5%), updated to 2007^{6,14,20} (Table 1). Finally, it has been estimated that road assistance intervention would be necessary in all cases of accidents with victims (26.063 accidents), applying a cost of 135.47€, updated to 2007^{6,14,20} (Table 1).

Subsidies for temporary sick leave. According to the existing laws regarding welfare benefits for sick leave, under the perspective of the public sector, we took into account all acute hospital and long-term care stays shorter or equal to 20 days, and applied the 60% of the mean monthly labour cost in Catalonia in 2007^{24,25}. For those stays longer than 20 days, we applied the 75% of the mean monthly labour cost^{24,25} (Table 1).

Productivity losses due to institutionalization. Under the perspective of the society, acute hospital and long-term care stays have been taken into account, applying the mean labour cost in Catalonia in 2007, correcting for the unemployment rate^{24,26} (Table 1).

Subsidies for permanent sick leave. In the base case, it has been considered only that severely injured (13.5%) would have a permanent sick leave, applying the mean labour cost in Catalonia in 2007, correcting for the unemployment rate^{16,24,26,27} (Table 1). In the sensitivity analysis the time horizon has been broadened to include permanent sick leave of injured people during the rest of their working life. We assumed a mean loss of 40 working years, and applied the mean labour cost in Catalonia in 2007, correcting for the unemployment rate^{16,24,26,27}. In the sensitivity analysis, it has been also been considered two months off sick leave for those slightly injured (86.5%), applying a mean labour cost in Catalonia in 2007, correcting for the unemployment rate^{14,16,24,26,27} (Table 1).

Productivity losses due to work sick leave. Under the perspective of the society, it has been considered that those severely injured (13.5%) would have a year off sick leave, applying the mean work cost in Catalonia in 2007, correcting for the unemployment rate^{14,16,24,26} (Table 1). In the sensitivity analysis the time horizon has been broadened to include productivity losses during the rest of the working life. We assumed a mean loss of 40 working years for those severely injured (13.5%), and applied the mean work cost in Catalonia in 2007, correcting for the unemployment rate^{14,16,24,26}. For those slightly injured (86.5%), it has been considered that they had two months of sick leave, applying the mean work cost in Catalonia in 2007, correcting for the unemployment rate^{14,16,24,26} (Table 1).

Productivity losses of carers. Under the perspective of the society, it has been estimated that those severely injured (13.5%) would need 1.5 hours of medium support per day in the realization of their activities of daily living, with its corresponding cost updated to 2007^{19,20}. In the sensitivity analysis, it has been considered 6.5 hours intense support per day in the realization of activities of daily living, with its corresponding cost updated to 2007^{19,20} (Table 1).

Presentation of results. All estimations have been carried out and reported following the existing and commonly accepted methodological guidelines. Results are presented in Euros 2007. The results are presented in the form of a base case, and also a maximum estimation of the sensitivity analysis is presented. To have a relative measure, the cost per injured person has been calculated, using as a denominator the total number of acute hospital admissions.

RESULTS

The results of the calculations for every concept and perspective could be seen on Table 2. From the perspective of the healthcare system, the cost of injured people in traffic accidents was 31,803,034.03€. Of these, the most important part corresponded to acute hospital care (16,645,657.10€; 52% of the total), followed by rehabilitation care (9,105,330.28€; 29%), and ambulances and transport (3,900,921.20€; 12%). In Figure 1 the distribution of direct and indirect costs could be seen.

From the perspective of the public sector, the cost of injured people in traffic accidents was 134,047,059.27€ (up to 1,463,645,407.13€ in the sensitivity analysis). In this case, indirect costs (subsidies from temporary and permanent work sick leave) were of major magnitude than direct ones: 85,234,121.70€ indirect costs (up to 1,409,462,424.72€ in the sensitivity analysis, and 36.4% of the total) and 48,812,937.57€ direct costs (up to 54,182,982.41€ in the sensitivity analysis, and 63.6% of the total). Among indirect costs, one could highlight subsidies for permanent work sick leave (72,191,453.46€; up to 1,396,419,756.48€ in the sensitivity analysis). Among direct costs, acute hospital care (16,645,657.10€), but also rehabilitation care (9,105,330.28€), police, fire-fighters, and road assistance (5,348,943.72€) and disability benefits (11,660,969.82€, and up to 17,031,014.66€ in the sensitivity analysis) stand up.

Finally, from the perspective of the society, the costs of injured people in traffic accidents are 144,043,238.88€ (up to 1,558,926,995.12€ in the sensitivity analysis). Indirect costs were more important than direct ones (84,792,313.71€, and up to 1,427,865,952.14€ in the sensitivity analysis). Productivity losses due to work sick leave represented 85%

(72,191,453.46€, up to 1,396,419,756.48€ in the sensitivity analysis). Among the direct costs, acute hospital care (16,645,657.10€; 28% of the direct costs), material costs (15,637,800.00€; 26%), rehabilitation care (9,105,330.28€; 15%) and police, fire fighters, and road assistance (5,348,943.72€; 9%) were the most important ones. The distribution of direct and indirect costs from the perspective of the society could be seen in Figure 1.

The cost per injured person ranged from 3,855.38€ from the perspective of the healthcare system, to 16,250.10€ from the perspective of the public sector (up to 177,433.07€ in the sensitivity analysis), and to 17,461.90€ from the perspective of the society (up to 188,983.76€ in the sensitivity analysis).

DISCUSSION

The results of the analysis showed that, from the perspective of the healthcare system, the cost of injured people in traffic accidents in 2007 was 31,803,024.03€; from the perspective of the public sector it was 134,047,059.27€ (up to 1,463,645,407.13€ in the sensitivity analysis); and from the perspective of the society it was 144,043,238.88€ (up to 1,558,926,995.12€ in the sensitivity analysis). The cost per injured person ranged from 3,855.38€ from the perspective of the healthcare system to 17,461.90€ from the perspective of the society (up to 188,983.76€ in the sensitivity analysis).

One could point out the relative importance of indirect costs (either in the form of subsidies for temporary or permanent work sick leave, or in the form of productivity losses due to institutionalization, work sick leave, or productivity losses of carers), which offset direct costs. As a matter of fact, injuries -even those considered slight- have been identified in the literature as a source of costs, mainly due to their frequency (in the present analysis, we considered that of the 8,249 injured, 86.5% were slight) and their extended morbidity^{28,29,30}. Among direct costs one could highlight acute hospital care costs, as well as specialized care, police, fire fighters and road assistance, and disability benefits have also a lot of importance.

The results of this study are in the line of others done in Spain. Comparing this study with the former ones, the included costs have been the same ones; the values and the number of cases vary according to information sources, assumptions made in the analysis, and prevalence values. It is worthwhile mentioning that this study limits itself to calculating the cost of injured people in traffic accidents, while all the former studies took into account injured

people and deaths. This is the reason why resulting costs are lower. It is also worthwhile commenting that all previous studies have included higher administration and material costs.

The imputation of the different concepts of costs to a specific disease -in this case, injuries due to traffic accidents- is not exempt from practical issues, like the difficulty to assign a global cost to a year or to a specific activity. We used a “bottom-up” estimation, in contrast with other estimations “top to bottom”. In other words, our estimations have not been made using attributable fractions applied to total costs for each concept; instead, we made our estimations using the epidemiological information available and applying reimbursement tariffs or mean costs to each case. This makes the estimations far more conservative, because the lack of information in some cases or the low quality of the existing registries in others has made some of the calculations impossible. On the other hand, the main limitation of working with attributable fractions is the overestimation of costs, since a proportion of the global cost is assigned to each of the concepts. If this percentage is not accurate enough or varies depending on what is being analyzed, inaccuracies can be introduced in the calculations.

As it has been mentioned, each cost has been included in the estimation according to the perspective of analysis considered. For instance, from the point of view of the society, subsidies are transfers that the State does in favour of persons who fulfil a series of requirements, without the wealth of the country being reduced, for which they do not suppose an additional social cost and have not been included in the analysis^{31,32}. However, from the perspective of the public sector they suppose an additional expense, and for that they have been taken into account. It also is worthwhile clarifying that to calculate the productivity losses, we used the mean gross monthly work cost, including workers remuneration and social security contributions paid by the employer. The inclusion of contributions is justified

because this value reflexes the social value of the productivity of a worker (in other words, the availability to pay revealed by the company), and not only the individual private value³³.

Compensation costs have not been included, since they beared by insurers, and therefore cannot be included under the perspective of the healthcare sector nor in the perspective of the public sector; under the perspective of the society it would be incorrect to include them because they are transfers from the insured persons to the injured ones.

Like in any study of cost of the illness, the estimations made are not absent from limitations, the majority of them related with the lack of information about some aspects of resource consumption, which the estimation of a money value has made impossible for some concepts. For instance, firstly, it is possible that the number of accidents with victims is underestimated, given that the source of the data is the police, and they only record those accidents where they intervene. In a similar way, it is possible that the number of acute hospital and long-term care episodes and stays is underestimated, since private hospitals paid by insurance companies are not forced to inform the registries.

Secondly, again the lack of information made impossible to take into account the cost of technical aids for people with visual or hearing disabilities resulting from a traffic accident, given that the number of cases was not known. However, we could assume that this number is very small²¹. Also, the utilization of mean values to estimate adaptation costs due to disability and the amount of money grants, could make some results not completely accurate. Also related with the lack of information, the data on the severity of injured people comes from the police, and their classification does not follow clinical criteria. Some researchers

have calculated severity using the diagnoses stated in the hospital registry, which is not free from limitations either, since there may be missing cases and incomplete registries.

Thirdly, the lack of detailed information about costs of research and prevention policies in traffic accidents, made impossible to include them, as it was the case for traffic congestion costs^{34, 35}.

In other cases, however, the imputation of some costs is controversial. This would be the case of administration costs that some studies include in their whole. In this study, we decided to include only the marginal cost related with the management of compensations, and to exclude the rest of administrative costs, considering that they would exist regardless of the eventuality of the traffic accident and the injury.

Results of cost of illness studies are a good basis to quantify a health problem, and to evaluate the efficiency of the interventions available to address it. In our context, in the last years many policies (driving license point system, installation of speed cameras, speed enforcement, etc) have been carried out, and their effectiveness has been scarcely evaluated and not at all its efficiency³⁶. The present information, with an exhaustive revision of information sources and bibliography, is a good starting point for the evaluation of these recent interventions.

As we have mentioned, the reduction of traffic accidents is one of the goals of the European Commission for this decade⁸. As a matter of fact, many of the proposed measures are supported by economic evaluation studies proving their efficiency. Among them we could find the installation of speed radars, the utilization of airbags, the compulsory use of helmet,

and the use of lights during the day^{37,38,39,40}. The importance of the costs of those injured in traffic accidents is an additional argument, besides their epidemiological and social impact, to start off prevention policies.

Table 1. Units, prices, and information sources used in the analysis. Catalonia, 2007.

Concept	No. Units	Price	Source
Direct costs			
Primary care	26,316 injured people not admitted to hospital	1 visit = 49.04€	6,17
Acute hospital care	8,249 discharges	1 discharge = 2,017.90€	17
Emergency care	8,249 visits	1 emergency = 82.04€	17
Ambulances and transport	8,249 transports	Ambulance transport = 210€ Helicopter transport= 2301€	Personal communication
Long-term care	3.573 days of stay	1 estada = 51.45€	18
Rehabilitation care	470 severely injured people	1 hour fisiotherapy/day = 30.07€ 1 hour nursing/month = 30.07€	19
	7.779 slightly injured people	1 hour nursing/month = 30.07€	19
Adaptation to disability	470 severely injured people	Home adaptation = 801.80€ Tecnical aids and orthopaedic material =	19

		520.80€-1,382.09€ Vehicle adaptation = 2,896.78€-4,643.97€	
Disability benefits	470 severely injured people	Diability benefits = 9,077.82€ - 13,029.10€ Deductions on taxable income = 1,393.45€ – 2,264.36€	19
Material costs	26,063 accidents with victims	600€ and 900€ (1% at 10,500€)	6,21
Administrative costs	470 severely injured people 7,779 slightly injured people	44.26€	6,22
Police	470 severely injured people	608.00€	14
	7.779 slightly injured people	306.31€	14
Fire fighters	470 severely injured people	260.90€	14
	7.779 slightly injured people	123.14€	14
Road assistance	26.063 accidents	159.66€	6

	with victims		
Indirect costs			
Temporary sick leave	7,961 injured people ≤20 days of stay 288 injured people >20 days of stay	2,612.40€/month	24,25,26
Institucionalitzation	84,461 days	2,612.40€/month	24,25,26
Permanent sick leave	8,249 injured people	2,612.40€/month	24,26,27
Work sick leave	8,249 injured people	2,612.40€/month	24,26,27
Work leave of carers	470 severely injured people	1 hour/day = 8.13€, 1.5 – 6.5 hours/day	19

Table 2. Results of the analysis according to the perspective of analysis. Catalonia, 2007.

Concept	Healthcare perspective	Public sector perspective	Society perspective
Direct costs			
Primary care	1,290,536.64	1,290,536.64	1,290,536.64
Acute hospital care	16,645,657.10	16,645,657.10	16,645,657.10
Emergency care	676,747.96	676,747.96	676,747.96
Ambulances and transport	3,900,921.20	3,900,921.20	3,900,921.20
Long-term care	183,830.85	183,830.85	183,830.85
Especialized care	9,105,330.28	9,105,330.28	9,105,330.28
Adaptation to disability	-	-	5,559,987.94 (8,464,835.06)
Disability benefits	-	11,660,969.82 (17,031,014.66)*	-
Material costs	-	-	15,637,800.00 (23,456,700.00)
Administrative costs	-	-	365,100.74
Police, fire fighters, road assistance	-	5,348,943.72	5,348,943.72
Total direct costs	31,803,024.03	48,812,937.57 (54,182,982.41)	59,250,925.17 (131,061,042.98)
Indirect costs			

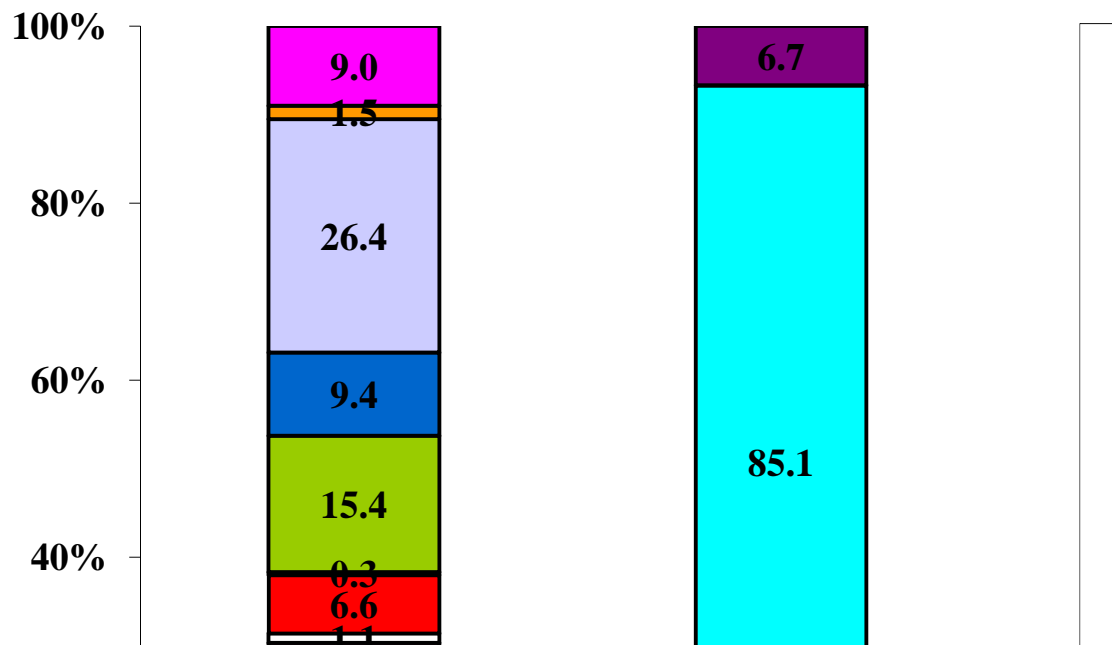
Temporary sick leave	-	13,042,668.24	
Institucionalitzation	-	-	6,884,309.25
Permanent sick leave	-	72,191,453.46 (1,396,419,756.48)	-
Work sick leave	-	-	72,191,453.46 (1,396,419,756.48)
Work leave of carers	-	-	5,716,551.00 (24,561,886.41)
Total indirect costs	-	85,234,121.70 (1,409,462,424.72)	84,792,313.71 (1,427,865,952.14)
Total	31,803,024.03	134,047,059.27 (1,463,645,407.13)	144,043,238.88 (1,558,926,995.12)
Cost/injured person	3,855.38	16,250.10 (177,433.07)	17,461.90 (188,983.76)

The results of the sensitivity analysis are shown in parenthesis.

US Euro/dollar = 0.7297; European Central Bank reference exchange rate, 2007 average.

[http://sdw.ecb.europa.eu/browseSelection.do?DATASET=0&FREQ=A&CURRENCY=USD
&node=2018794](http://sdw.ecb.europa.eu/browseSelection.do?DATASET=0&FREQ=A&CURRENCY=USD&node=2018794)

**Figure 1. Distribution of direct and indirect costs, from the perspective of the society.
Catalonia, 2007.**



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