Age on the incidence and severity of occupational injuries: Empirical evidence using Spanish data*

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Abstract

The aim of this paper is to study the impact of the worker's age on the incidence and severity of occupational injuries, as well as in the duration of the sick leave caused by them. Using data from the *Estadistica de Accidentes de Trabajo* in 2008, we estimate a model that analyses the impact of the age on the probability of severity of injuries, once the accident has happened. Further, we estimate a duration model in order to study the influence of the age on the extension of the sick leave caused by occupational injuries. The conclusions show that, when the worker's and job's characteristics and the type of accidents are controlled for, the probability that the accident is severe or fatal, as well as the duration of the sick leave, increases with the worker's age.

JEL Codes: J14**,** J28**,** J81

Key words: occupational injuries, age, severe and fatal injuries, sick leave, incidence rates

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1. Introduction

One of the topics that is currently generating an intense political, economic and social debate in Spain is that related to the ageing of the population in general, and of the workforce in particular, together with the low activity rate of those workers between 55 and 65 years old. This process is likely to exert strong pressures on the labour market and on the working of its institutions.[1] As Flores (2009) summarises, this demographic pressure has led the European Union to develop some measures to foster what has been called "active ageing", within the Stockholm and Barcelona objectives. The main target is to achieve an increase in the participation rate of the elderly. These measures could be followed by complementary decisions by national governments, such as the delay in the mandatory retirement age, from the current 65 to 67, as stated recently by the Minister of Labour and Immigration. [2] If all of these measures succeed the most visible result would be an increased number of older workers in the labour market.

The repercussions of the ageing of the working population on the labour market are multiple (see *inter alia* Ghosheh *et al.*, 2006 or Villosio *et al.*, 2008). In this paper we analyse the impact of such event on the incidence and effects of the occupational injuries. The main objective of the paper is to analyse how the age of the worker influences the incidence and severity of occupational injuries, as well as the duration of the sick leave related to them.

When analyzing the relationship between age and occupational injuries, It is important to take into account that older workers may exhibit certain characteristics that may exert opposite effects. On the one hand, this type of workers are, in general, more experienced, and have a greater concern on the risks related to their job. These facts would tend to reduce the number of injuries suffered by this group. However, on the other hand, given their age, these workers have a decreased ability to avoid unexpected hits, suffer from diminished hearing and sight, as well as an excessive confidence, due to their experience, which could lead them to discard the prevention measures for certain risks. Therefore, *a priori*, It is not easy to disentangle in which way ageing affects occupational injuries. For this reason, and as stated in Root (1981) there are contradicting interpretations regarding the relationship between both variables. This

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[1] The Governor of the Bank of Spain, Miguel Ángel Fernández Ordóñez, has recently asserted that the current population dynamics will impose an increasing pressure on the public pension expenditures, such that the public pension system could run into a permanent deficit in 2025.

[2] However, this proposal is more related to the debate focused on the sustainability of the pension system.

paper tries to shed light on this debate, by providing empirical evidence relative to the effect of individual age on the incidence and severity of the injuries suffered by this group of workers.

The existing literature on the topic can be divided under two different lines of work. First, there are a number of papers which analyse the determinants of occupational injuries, including the age of the worker among the explanatory variables. In this line Ruser (1995) using data from the *Census of Fatal Occupational Injuries* for the years 1992 and 1993 in the US estimates which groups of workers are exposed to a greater relative risk of a fatal accident. He finds that the probability that a worker older than 65 dies due to an occupational injury is four times greater than that of a worker between 25 and 34. Also we should mention Dupré (2001) who uses data from the European Statistics on Job Accidents and the module on occupational injuries and professional diseases included in the European Labour Force Survey of the second quarter of 1999. He finds that those workers between 55 and 64 show a 13.1% lower probability than the average to suffer an injury, but the probability of suffering a fatal injury is 53.6% higher than the average. Viscusi (1979) uses data on industry health and safety investments and injury rates for the 1972-1975 period for studying any impact of Occupational Safety and Health Administration (OSHA). He introduces a set of explicative variables, among them the percentage of workers age 24 and under and the percentage aged 45 and over were included to reflect age-related differences in job types and accident propensities. He finds that the percentage of workers aged 45 and over has negative effect on injury rates. Focusing on the literature for the Spanish labour market, an interesting descriptive analysis can be found in García and Montuenga (2004), who use data from the *Estadística de Accidentes de Trabajo* (Occupational Injuries Statistic) published by the Ministry of Labour. Using panel data they study the determinants of occupational injuries of Spanish workers. Among other results, they find that even though youngsters suffer more accidents, older workers suffer more severe consequences from accidents. García and Montuenga (2009) also use panel data for estimating the determinants of occupational injuries at the national level. Although they don't introduce the variable age in their estimations, they controlled by the variable *potential experience* and by *potential squared experience divided by 100*, indicators which are clearly related with the worker's age. They find that a greater experience reduces the risk of severe or fatal occupational injury, but this variable isn't significant for explaining the incidence of total or minor accidents. However, they find that the squared experience increases the risk of severe or fatal accident. This suggests that, when the experience increases, the positive effect is lower given that the negative effect of age on the probability of suffer an accident is increasing.

The second line of work is focused on the study of the relationship between age and occupational injuries. Root (1991) using data from the *Bureau of Labor Statistics Supplementary Data Systems* of the US for 1977, finds that young workers suffer more accidents, but the injuries are less severe than in the case of older workers. Similarly, Mitchell (1988) finds that the risk of an accident that causes temporal sick leave is independent of the age, but workers aged 65 and over exhibit a greater probability of suffering permanent sick leave and fatal accidents. Both papers find that their results are similar when they control for industry and occupation, which implies that the relationship between age and occupational injuries is not reflecting life-cycle differences in the jobs.

The revision of the previous literature and intuition suggest that the fact that the worker has reached a certain age is related to the presence of a number of personal characteristics that will have an impact on the probability of work accident: it could be inexperience or handling abilities in the early life, or experience and the loss of physical abilities in the late working years. The aim of this paper is to asses and to quantify the impact of these characteristics (many of them working in opposite directions) on occupational injuries, their severity and the duration of the sick leave caused by them.

In this context the paper is organised as follows. Section 2 summarises a descriptive analysis of the incidence of occupational injuries for different age groups. Section 3 provides an econometric analysis regarding the impact of age on severity of injuries. Section 4 summarises the result of the estimation of a duration model, and of the impact of age on the durations of the sick leave, while Section 5 presents the conclusions.

2- Descriptive analysis of the incidence of occupational injuries by group of age

In this section we develop a descriptive analysis of the distribution of labour accidents by age groups. We use as the main instrument of analysis the so-called incidence rates,[3] given that the absolute number of accidents can be influenced by the

[3] The incidence rate is the quotient between the total number of injuries of a certain type (total, severe, fatal, etc.) multiplied by 100,000 divided by the number of workers affiliated to the Social Security

evolution of aggregate employment. Data has been taken from the *Estadística de Accidentes de Trabajo* (EAT) compiled by the Ministry of Labour and Immigration and from the Labour Force Survey (*Encuesta de Población Activa*, EPA), published by the *Instituto Nacional de Estadística* (INE).[4]

Figure 1 shows the incidence rates of occupational injuries for different levels of severity in the years 1996 and 2008. In this graph we observe that incidence rates have been reduced between these two years for every group of age, this reduction being especially strong for the group of younger than 25. The pattern followed by minor injuries is essentially the same as that of total injuries, since these types of accidents represent around 98% of the total. However, the pattern for severe accidents is more marked. For all of the age groups, the rate in 1996 was higher than in 2008. Fatal injuries also exhibit a strong reduction in the incidence rates, such that in some groups the rate in 2008 was less than half that in 1996. The information in figure 1 allows asserting that since the Occupational Risk Prevention Act (ORPA) was passed in 1995, the incidence of occupational injuries has been markedly reduced, especially for the most severe cases.

On the other hand, figure 1 also allows observing which groups are affected by higher incidence rates. Thus, we observe that for total and minor injuries the incidence is progressively reduced with age. Workers less than 20 years old are more likely to suffer an injury in their workplace, the difference with respect to other groups being highly significant. When considering severe (non fatal) accidents, we observe that, again, workers of less than 20 have greater rates. However, the difference with the other groups is not so marked. Actually, workers between 54 and 65 also show very high

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system with the contingency of occupational injuries specifically covered for. In this way we isolate the analysis from the evolution of total employment.

[4] For an adequate calculation of the incidence rate we should include in the denominator the number of affiliated workers to the Social Security system, because these are precisely those covered in case of an occupational injury. According to the recommendations of the XVIth International Conference of Labour Statisticians of the I.L.O. incidence rates relate the number of new cases of occupational injury to the number of workers exposed to the risk of occupational injury. The difficulty in this measure stems from the lack of an appropriate figure for the denominator. In practice, the denominator is usually the total number of persons employed or the total number of persons insured at a particular time during the reference period, rather than workers in the reference group. Unfortunately, where the denominator is the number of persons insured, those who are insured but not working may be included, and the figure for total employment may therefore contain groups that are not covered by the statistics of occupational injuries. In Spain insured workers are those under the General Regime, Mining and Coal and Agriculture special regimes and, since 2004, those self-employed who have chosen to be specifically covered by their Special Regime. The lack of disaggregated data for insured workers for each of the categories considered in our analysis forced us to proxy the denominator of the rate by the employment figures provided by the Labour Force Survey.

incidence rates. Finally, if we consider fatal injuries we observe a radically different picture: incidence increases with age, and older workers show the highest incidence rates for this type of accidents.

<FIGURE 1>

Results in Figure 1 may be conditioned by the fact that some occupations or activities may have a greater share of young or old workers. Therefore, we next analyse the incidence rates using different grouping criteria.

Table 1 shows the incidence rates of total occupational injuries by occupation and age group. For all types of occupation, with the exception of the Armed Forces, we observe a higher incidence of occupational injuries among younger workers, decreasing uniformly with worker's age.

<TABLE 1>

Table 2 shows the incidence rates of total occupational injuries by economic activity and age group. For the most part of economic activities, we observe a greater incidence in younger workers (under 20), with the exception of *Other community, social and personal service activities* and *Activities of households* in which we observe a high incidence for workers aged between 30 and 50. In some activities such as *Real estate, renting and business activities* and *Financial intermediation*, we observe a moderate increase of incidence for workers aged between 40 and 60. However, these results may be conditioned by the fact that almost all of the accidents are minor. Therefore, we focus our attention on severe accidents, and for the same age groups as in Table 2.

<TABLE 2>

In the case of severe and fatal injuries, we observe the highest incidence rates for the oldest workers, especially those between 60 and 64. Table 3 provides a breakdown of these indexes by occupation and age group. For almost all occupations, the highest incidence rate of severe and fatal injuries is for the oldest workers. The exceptions are occupations such as *Technicians and associate professionals*, *Plant and machine operators, and assemblers* and *Elementary occupations*, in which the youngest workers (under 20) have the highest incidence rate.

<TABLE 3>

If we take into account the type of economic activity we also observe that, for almost all activities, the oldest workers have the highest incidence rates of severe and fatal injuries (Table 4). However, in other activities as *Fishing*, *Mining and quarrying*, *Manufacturing* and *Electricity, gas and water supply*, we observe the highest rates for the youngest workers (under 20 years old).

<TABLE 4>

So far we have observed that older workers, even though on the aggregate show lower incidence rates, when they suffer an occupational injury, this tends to be more severe. This fact may be a reflection that most part of the observed differences between age groups is due to diminishing physical conditions consistent with older age. For instance, body coordination tends to decrease with age, which probably contributes to a greater number of injuries due to falls. Precisely, this is what we observe in Table 5, where we show that while hits caused by a fall represent 11% of total injuries for younger workers, these represents between 18.4% and 28% in the case of older workers. Consequently, while injuries resulting from a fall represent the fifth most common injury among young workers, they represent one of the two most common injuries among older workers, together with *overreaction, physic trauma, and exposure to radiation, light or pressure*.

<TABLE 5>

On the other hand, Table 6 shows the percentage of occupational injuries according to how the accident happened and the description of the injury for workers between 16 and 54 years old and for workers aged 55 or more. The table shows that the same type of accident has more serious consequences for workers aged 55 or more. For example, a hit caused by a fall involves more usually bone fractures in the case of ageing workers than in younger ones (19.1% and 13.2% respectively), while, in the case of younger workers, the same hit results, more often, in sprains and dislocations (46.3% and 37.4%). This same pattern can be found for other traumatic injuries. Thus, a hit against an immobile object results in the 11.5% of the cases in a bone fracture for older workers, while this percentage falls to 8.4% for workers aged less than 55. This same type of injury results in sprains and dislocations more often in the group of workers below 55 than in the group of 55 and more (43.6% and 51% respectively). In sum, a similar accident results more often in more severe consequences when considering the description of the injury when the accident is suffered by an older worker.

<TABLE 6>

Along this section we showed that young workers suffer more occupational injuries, but the consequences of these accidents are less severe than in the case of older workers. This result holds even when we consider the type of occupation and the economic activity. Furthermore, we observe that the physiologic characteristics of the worker imply a concentration of a certain type of accidents, and that when the accident happens the injury is generally more severe than in the case of younger workers. In the next section, we try to analyse econometrically if once that we control for all of the personal characteristics of the worker and of his/her workplace, age remains a determinant of the severity of occupational injuries, provided that the accident has happened.

3- The impact of age on the severity of occupational injuries

The aim of this section is to evaluate empirically the impact of worker's age on the severity of occupational injuries. Specifically we want to identify if once the accident has happened the age of the worker has a significant effect on the severity of the injury.

To this end we estimate an ordered probit model, with a three level dependent variable: 1 for minor injuries, 2 for severe and 3 for fatal injuries. In the empirical model we include as many explanatory variables as possible, in order to isolate the effect of age from other sources or determinants of severity.

In the ordered probit model we assume the existence of a non observable latent variable Y_i^*, not limited in its variation range, which depends on the vector of explanatory variables X_i . Over this latent variable we impose an observability rule which generates the observed values in the sample. Therefore, the values taken by the observed variable may be described by the following scheme:

$$Y_i = \begin{cases} 0 & \text{if} \quad Y_i^* \leq c_1 \\ 1 & \text{if} \quad c_1 < Y_i^* \leq c_2 \\ \dots & \\ (M-1) & \text{if} \quad Y_i^* > c_{(M-1)} \end{cases} \tag{1}$$

where $c_1, c_2, \dots, c_{(M-1)}$ are the threshold values or barriers (to be estimated).

Our starting equation is:

$$Y_i^* = X_i\beta' + \varepsilon_i \tag{2}$$

where Y_i^* is the unobserved latent variable, $Z_i = X_i\beta'$ is the index of the model, ε_i is a random error, which we assume follows a standardised normal distribution function *F(.)*.

From this equation we may write the probability of belonging to each group:

$$P(Y_i = 0|X_i, \beta, c) = F(c_1 - X_i\beta')$$

$$P(Y_i = 1|X_i, \beta, c) = F(c_2 - X_i\beta') - F(c_1 - X_i\beta')$$
$$P(Y_i = 2|X_i, \beta, c) = F(c_3 - X_i\beta') - F(c_2 - X_i\beta')$$
$$\dots \tag{3}$$
$$P(Y_i = (M-1)|X_i, \beta, c) = 1 - F\left(c_{(M-1)} - X_i\beta'\right)$$

The threshold values c_m are new parameters included in the model, and are jointly estimated together with the β's by maximum likelihood and with non linear optimisation algorithms which take into account the restriction $c_1 < c_2 < c_3 < ... < c_{(M-1)}$ such that all of the probabilities are positive.

On the other hand, we may compute the marginal effect of each of the independent variables on each of the categories by:[5]

$$\frac{\partial P(Y_i = 0)}{\partial X_{ki}} = -f(c_1 - X_i\beta')\beta_k$$
$$\frac{\partial P(Y_i = 1)}{\partial X_{ki}} = \left[-f(c_2 - X_i\beta') + f(c_1 - X_i\beta')\right] \beta_k$$
$$\frac{\partial P(Y_i = 2)}{\partial X_{ki}} = \left[-f(c_3 - X_i\beta') + f(c_2 - X_i\beta')\right] \beta_k$$
$$\dots$$
$$\frac{\partial P(Y_i = (M-1))}{\partial X_{ki}} = f(c_{(M-1)} - X_i\beta')\ \beta_k \tag{4}$$

where *f(.)* is the normal density function, *N(0,1)*.

We use data from the Occupational Injuries Statistics *(Estadística de Accidentes de Trabajo)*, published by the Spanish Ministry of Labour and Immigration, which is a registry of all of the accidents that cause sick leave. Employers must fill in a form where they report (through the so called "*Parte de Accidentes")* all of the information related to the accident. The micro data is gathered and published on a monthly and yearly basis, but here we will use the individual information provided by the statistic. Specifically, our dataset contains information regarding all of the occupational injuries in 2008,[6] excluding *in itinere* accidents, i.e., those occurred while the worker is commuting to or from his/her workplace. We also drop from the sample the relapses.[7] Our sample,

[5] Cameron and Trivedi (2009)

[6] 2008 is the last year for which there is available information.

[7] The Spanish social security system covers certain type of workers from both occupational injuries and occupation diseases. However, the latter are very difficult to prove, since it is difficult to relate causes and

therefore consists in 797,250 occupational injuries, of which 789,615 (99.04%) were minor, 6,830 (0.86%) were severe and 805 (0.10%) were fatal.

From this dataset we observe, for each registered occupational injury, the severity level, and a number of personal characteristics of the worker, of his/her workplace and of the context of the accident. Among the first group we observe gender, age (grouped in 8 levels, from "16 to 19" to "over 65"), region, occupation level, firm size (grouped from firms of 1 to 5 workers to firms of more than 1,000 employees), type of contract (permanent or fixed-term), place where the accident occurred (in the workplace, commuting during working day or in a different workplace), hour of the workday when the accident happened, day work or night work, if the type of activity carried out by the worker constitutes his/her usual task, and additionally we include control variables of the severity of the accident, as the part of the body injured, description of the injury and the way the accident happened (hits, falls, burns, etc.). The specialized literature on occupational risks has identified the expected effects of each of these variables on the severity of accidents, taking into account statistical collection. Therefore, we expect firm size to affect severity, given that the *ORPA* specifies different prevention regimes depending of the number of workers in the firm. We also expect an effect of the place where the accident happened on the severity (generally, more severe accidents happen outside the usual workplace), the hour of the working day (first hours exhibit greater probability of accident), the fact that the job is a night job or not, etc. Through the estimation of this model we try to identify the effect of the worker's age on the probability of suffering a more severe injury. The results of the estimation of the probit model are summarised in Table 7. The estimation is statistically significant, with an acceptable goodness of fit. On the other hand, the signs of the variables, and the values of the marginal effects are as expected (the latter are summarised in the last three columns of the table).

<TABLE 7>

From the results reported in table 7 we may conclude that men show a higher probability of suffering a severe injury than women (this result is in line with those of García and Montuenga, 2004 and Bande and López, 2009). We also observe a high degree of regional heterogeneity, such as injuries in Andalucia, Extremadura, and Galicia tend to be more severe. The activity branch related to a greater severity is

effects. For these reasons, all of the diseases originated at the workplace but not stated as "occupational diseases" are treated statistically as occupational injuries.

Fishing, while from the occupational point of view white collar workers tend to exhibit a greater probability of severe injuries. Also, the probability that the accident causes a severe or fatal injury is decreasing with firm size (coherent with the prevention regime organization in the firm). Permanent contracts are related to less severe accidents (in line with Amuedo-Dorantes, 2003, or Hernanz and Toharia, 2006). Regarding the circumstances where the accident took place, these tend to be more severe when it happens outside the usual workplace, during night work, if developing a different task than usual and after a certain number of working hours.

Regarding the impact of age on the severity of accidents, we find that the probability that an occupational injury, once the accident has happened, is severe or fatal clearly increases with age. Taking the group of young workers (from 16 to 19) as a reference, we observe that for every age group the probability of a more severe accident increases from 9% for the 25 to 29 group to a 32% for the group of 65 and older. Furthermore, this higher probability is increasing with age, i.e., the older the worker, the greater probability that the accident will be severe or fatal. The computation of the marginal effects confirms this result. The impact on the probability of suffering a severe accident caused by the variable "age" is positive and increasing with it. With respect to fatal accidents, the result is similar, and thus, workers of 60 and more show a greater probability that the accident is severe or fatal.[8]

This evidence suggests that once we control for the main personal characteristics of the worker, his/her workplace and the way the accident took place, the variable "age" increases significantly the probability that, once the accident has happened, the resulting injuries are severe or fatal. In this respect, even though the *ORPA* had a great success in reducing the overall number of occupational injuries and its incidence, especially those more severe and fatal, there are still some aspect where some legal regulation is still needed. The *ORPA* was a legislative reaction to the high level of incidence of occupational injuries in the 90's, with a special emphasis on the immediate physical

[8] We estimated the same model including the variable "experience", with similar results to those reported in table 7. Specifically, we observe that this variable only becomes significant when the worker has been employed in the firm for at least three years. While we observe that when we include experience the probability that the injury is severe or fatal is reduced for every age group of more than 30, this reduction is marginally significant. Moreover, the marginal effects confirm that even including the experience as an explanatory variable, the probability that a worker of 60 or more suffers a severe or fatal injury is much greater than for younger workers. Given these results we conclude that the impact of age on the severity of occupational injuries is mainly determined by the physiological characteristics of the worker. In other words, being an experienced worker does not prevent from a severe or fatal injury once the accident happened. Injuries are not more severe due to an excess of confidence due to experience. The results from this auxiliary regression are available upon request.

determinants of occupational injuries, such as the manipulation of hazardous materials, body protection, signaling, etc. Age was not specifically considered as a determinant of occupational injuries, and our econometric results suggest that some legal reform is needed in this regard, given that the effect of this variable on the probability that an accident results in more severe injuries is as important as the usual suspects (for example, if the accident took place in the main workplace or not).

The analysis of occupational injuries and its determinants is strongly related to a rather different issue, the length of the sick leave associated to each injury. The expected result is that more severe injuries should be related to longer sick leave. The next section deals with this issue, trying to identify if age is a significant variable in the explanation of the duration of the sick leave caused by occupational injuries.

4.- The impact of age on the duration of sick leave caused by occupational injuries

Our previous results in section 3 suggest that the older a worker is, the greater the probability that if he/she suffers an occupational injury, it would be severe or fatal. The expected result in terms of the duration of sick leave is longer spells the older the worker. This fact would have an immediate impact on the health care cost (either public or private), and therefore should be added to the relevant information set in the debate regarding, for instance, the delay of the mandatory retirement age from 65 to 67. In this section we econometrically assess the impact of age on the duration of sick leave caused by occupational injuries.

Our main objective is to analyse the impact of the personal characteristics of the worker (among them his/her age) and of his/her workplace on the duration of the sick leave, since he/she suffers the injury until he/she transits to activity, what we call "transition" or "failure". Specifically we are interested in the number of days between when a worker suffers an occupational injury until he/she returns to his/her workplace, and in determining the effect of personal and job characteristics on such length. For this reason we make use of the econometric duration models, which we describe briefly hereunder.

Let us consider a population of individuals. For each individual we observe the period of time until the transit or the loss (censoring)[9]. In our model we observe the number of days that a worker is on sick leave, and call this variable *T*. Let us define *f(t)* as the probability density function of variable T in period t. The distribution function may be written as:

$$F(t) \; = \; \int_0^t f(s)\, ds \; = \; Prob\,(T \leq \; t)$$

The survival function is the probability that the length of duration is of at least *t* days:

$$S(t) \; = \; 1 - F(t) = Prob(T \geq t)$$

The hazard rate is the probability that the durations ends, i.e. there is a transit in the interval $t + \Delta t$, assuming that the length of the duration is of at least *t*:

$$h(t) = \lim_{\Delta t \to 0} \frac{Prob(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t} = \lim_{\Delta t \to 0} \frac{F(t + \Delta) - F(t)}{\Delta S(t)} = \frac{f(t)}{S(t)}$$

From a dynamic perspective the concept of the hazard rate is the most interesting when we try to model duration.[10] If we focus on the distribution function exclusively we could analyse complete durations only (those not right-censored). The analysis of the survival function would allow us to analyse incomplete durations only (those right-censored). The main advantage of estimating the hazard function is that we can use all of the available observations, right-censored or not. Additionally, it can be shown that the three functions are mutually related. Specifically, the hazard function is:

$$h(t) = \frac{-d\; ln\, S(t)}{dt}$$

and therefore, the probability density function may be written as:

$$f(t) = S(t)h(t)$$

[9] The main problem related to duration models is that of censured data. There are several types of censoring. Left censoring occurs when we do not know the starting moment of the event; right censoring occurs when the ending moment of the event in unknown; and interval censoring occurs when both are unknown. In our case we face right censoring. This may be caused by two different reasons. First, it may be the case that the analyst observes the duration before the transit occurs; second, it may be the case that the phenomenon under study ends before we observe the transit. Our dataset shows the first type of right censoring, given the annual structure of the register. There are injured workers in 2008 that at the end of the year are still under sick leave, and these will not be present in the 2009 data, since the *EAT* registers occupational injuries *along* the year. In any case we have full durations for 85% of total observations. Additionally, our empirical approach makes use of the remaining 15% for the estimation, as we describe next.

[10] Duration models are characterised by the way they specify the hazard rate or failure rate. The hazard function provides the values of the hazard rate for each value of *t*.

There are different duration models, depending on the way the hazard rate is specified. Thus, we can identify the non-parametric approach (Kaplan and Meier, 1958), the parametric and the semi-parametric (Cox, 1972).[11] Given that our dataset covers all of the occupational injuries causing sick leave throughout 2008, we follow the semi-parametric approach and specify the hazard function as in Cox (1972).[12] In this approach Cox introduces a proportional hazard model to estimate the effects of a set of independent variables on the hazard rate. We are interested in determining if the likelihood of an event differs systematically across individuals.

The main feature of these models is that different individuals exhibit different proportional hazard functions, i.e., the ratio of two hazard functions for different individuals with different vectors of independent variables does not depend on time t. Therefore, the hazard function may be written as the product of a function (which depends on time) and another function (which depends on the vector of independent variables). Formally,

$$h(t;X) = h_0(t) \cdot h(x,\beta)$$

where $h_0(t)$ is the base hazard function, any function of time common to all individuals, and $h(x,\beta)$ is the function that provides the effect of the explanatory variables, shifting the base hazard rate upwards or downwards, depending on the sign. Therefore, we may observe that the effect of the independent variables is to rescale the base hazard function. The most common functional form for h is $h(x,\beta) = e^{x\beta}$. With this specification we assure the non-negativity of the hazard function without imposing restrictions on the parameters β.[13]

[11] The main differences between these three approaches are related to the way they specify the hazard function. The non-parametric model considers that the hazard function depends on time exclusively, and therefore it rules out the effect of independent variables on the probability of transit. The semiparametric model considers the fact that there are a number of regressors that may exert an influence on the hazard rate, independently of time. Lastly, in the parametric approach the explanatory variables have an impact on the hazard rate which is dependent of time.

[12] In our model we do not explicitly control for unobserved heterogeneity due to the main characteristics of the dataset. To control for the presence of unobserved individual effects, we could estimate a fixed effect or a random effects model. As Green (2003) states, a random effect model would be suitable if the cross-section units of the sample are random draws from a large population. Our dataset is a register, and therefore provides us with all the population, not a sample. Therefore, the most adequate way to control for unobserved heterogeneity would be a fixed effects model. However, as Cleves *et al* (2008) point, the Cox model is not affected by the inclusion of fixed effects, since the base hazard function acts as an intercept, and the independent variables shift this hazard function upwards or downwards, depending on the sign. The effect of the independent variables would not be affected by the inclusion of fixed effects.

[13] The main advantage of this approach is that it is not necessary to specify an explicit functional form for $h_0(t)$, since the estimation of $h(x,\beta)$ provides the sign and magnitude of the shift in the base hazard function due to the variables included in $h(x,\beta)$, which is precisely what we are interested in.

In other words, we assume that the hazard function may be expressed as a product of a function of t and another function that only depends on $X_1, X_2, \dots, X_P$, i.e., the explanatory variables. In particular, if $h(x,\beta) = e^z$, Z being the linear combination:

$$Z = \sum_{j=1}^{p} \beta_j X_j = \beta_1 X_1 + \dots + \beta_p X_p$$

we have the Cox regression model.

Therefore, the estimated hazard function will be given by

$$\hat{h}(x,\beta) = e^{\hat{Z}} = (e^{B_1})^{X_1} \dots \dots (e^{B_p}) X_p$$

Thus, for fixed values of the remaining terms, the greater the value of the coefficient B_i, the greater the value of $h(x,\beta)$, and thus of $h(t,x)$. In other words, the greater the value of the coefficient B_i the greater the probability that the transit occurs in an interval $(t, t+\Delta t)$, provided it has not occurred before period t.

For the estimation of the Cox duration model we use the same dataset as in section 3, i.e., the Occupational Injuries Statistic *(EAT)* which provides all the micro data for the year 2008. From this dataset, we select those observations with a sick leave of at least one day (obviously we exclude the observations for fatal injuries). Our sample consists of 796,445 observations, for which we observe 677,991 complete durations (85%). Table 8 summarises the estimation of the model by maximum likelihood.

Table 8 provides the estimated β coefficients, which are interpreted as follows: a positive (negative) coefficient for a given regressor, implies that the variable increases (reduces) the hazard of transit (in our case it reduces/increases the number of days under sick leave), and therefore reduces (increases) the duration of the sick leave due to an occupational injury. Moreover, the table also provides the exponential of the estimated coefficients (e^{β}), which are interpreted as the elasticities of the hazard function with respect to each of the independent variables.

<TABLE 8>

Our results show that even though the probability of suffering a more severe accident is greater for men, women show a greater duration of sick leave, such that being a woman reduces the probability of discharge in a 5.5%.

With respect to the professional characteristics of the injured worker, we observe a positive sign for every activity branch, which means that the probability of discharge is greater than in *Fishing*, our reference. Regarding occupation, we observe that

Executives in private and Public Administration exhibit the greater probability of longer sick leave. Moreover, we observe that the duration of sick leave is reduced with firm size and with indefinite contracts. On the contrary, the probability of discharge is reduced if the injury took place outside the usual workplace, during night work or if it took place after a few hours of work.

Regarding age, our main concern, we observe that as we consider older age groups the probability of discharge is reduced, i.e., our results show a significant increase in the duration of the sick leave for older workers. Therefore, if the worker is 65 or more the probability of discharge is reduced by 45.2% with respect to a young worker between 16 and 19 (our reference). In other words workers of 65 and more remain more days under sick leave after an occupational injury. These results are similar to those reported in Corrales *et al.* (2008), where the age of the worker is a significant variable explaining the duration of sick leave due to occupational injuries, and the effect is clearly positive, i.e., as we consider older workers they observe greater delays in discharge.

In sum, our empirical evidence suggests that age is an important determinant in the explanation of sick leave duration related to occupational injuries. Once we control for the remaining determinants we find a positive relationship between age and sick leave duration, which implies a greater cost in health care.

5. Conclusions

The current debate regarding the extension of the mandatory retirement age from 65 to 67 years has attracted the public attention, both from the media and the academia, with strong opposite arguments between those defending the political decision and those opposed to it. In any case, and given the public statements of the main agents involved in this decision (Minister of Labour and Immigration, Governor of the Bank of Spain, unions and entrepreneur associations, etc.) it seems that the main underlying problem is the sustainability of the public pension system. This paper, however, brings into light different aspects of the decision of delaying the retirement age (or in other terms, increasing the number of older workers in activity), which remain hidden in the debate. Specifically, in this paper we analyse the impact of age on the incidence and severity of occupational injuries, as well as on the duration of the sick leave related to them. If severity and the duration of the sick leave increase with age, given the incidence rates we should expect that the delay of the retirement age would bring a greater number of severely injured workers. This may increase the health cost bill and thus compromise the potential gains from the delay in the retirement age (two more years of contributions, two years less of pension expenditures). If, on the contrary, severity of injuries does not depend on age, there would not be special risks derived from this political decision. In order to clarify this fact we need a detailed account of the impact of age on the incidence rates, the severity of the injuries and the duration of the sick leave related to them, and this is the contribution of the paper.

We developed our task in three steps. First, we conducted a descriptive analysis of the relationship between age and the incidence rates. We have found that in terms of incidence rates young workers suffer more overall injuries, but older workers suffer more severe injuries. The physiological characteristics of older workers make them more vulnerable to certain type of injuries, as hits due to falls. On the other hand, the same type of accident provokes a more severe injury in older workers than in the group of younger workers. In other words, the type of accident suffered is related to more severe injuries as we scale up the age group.

The second aspect considered in this paper has been the determinants of occupational injuries, in the same line as Bande and Fernández (2008) or Bande and López (2009). We estimate an ordered probit model, in which we explain the severity of the injury (once the accident took place) as a function of the personal characteristics of the worker and of his/her workplace. Our results allow asserting that once the accident has happened, the probability that it results in a severe or fatal injury clearly increases with age. On the other hand, our results indicate that the effect of age on the severity of the injury is mainly determined by the physiological characteristics of the worker, since experience at the workplace has a null effect on the severity of occupational injuries.

The last aspect considered in this paper has been the duration of the sick leave related to the injuries, and the impact of age on them. Our empirical analysis allows concluding that the duration of the sick leave increases significantly with age, once we have controlled for the personal characteristics of the worker, the workplace, the type of accident and the way it took place.

From a policy perspective our results suggest that the decision regarding increasing the total number of older workers in the labour market should be made with caution. If the retirement age is delayed, the *ceteris paribus* effect must be an increase in the total number of injured workers, with severe (and fatal) injuries and prolonged sick leave, which may increase the total public health cost expenses. Delaying the retirement age requires additional measures in order to minimise these effects. For instance, the functional reallocation of these older workers towards tasks with lower incidence rates (or less severe injuries) could help in alleviating the aforementioned effects. In any case, our work suggests that age is an important variable to explain occupational injuries in Spain, and therefore should be taken into account in the empirical studies.

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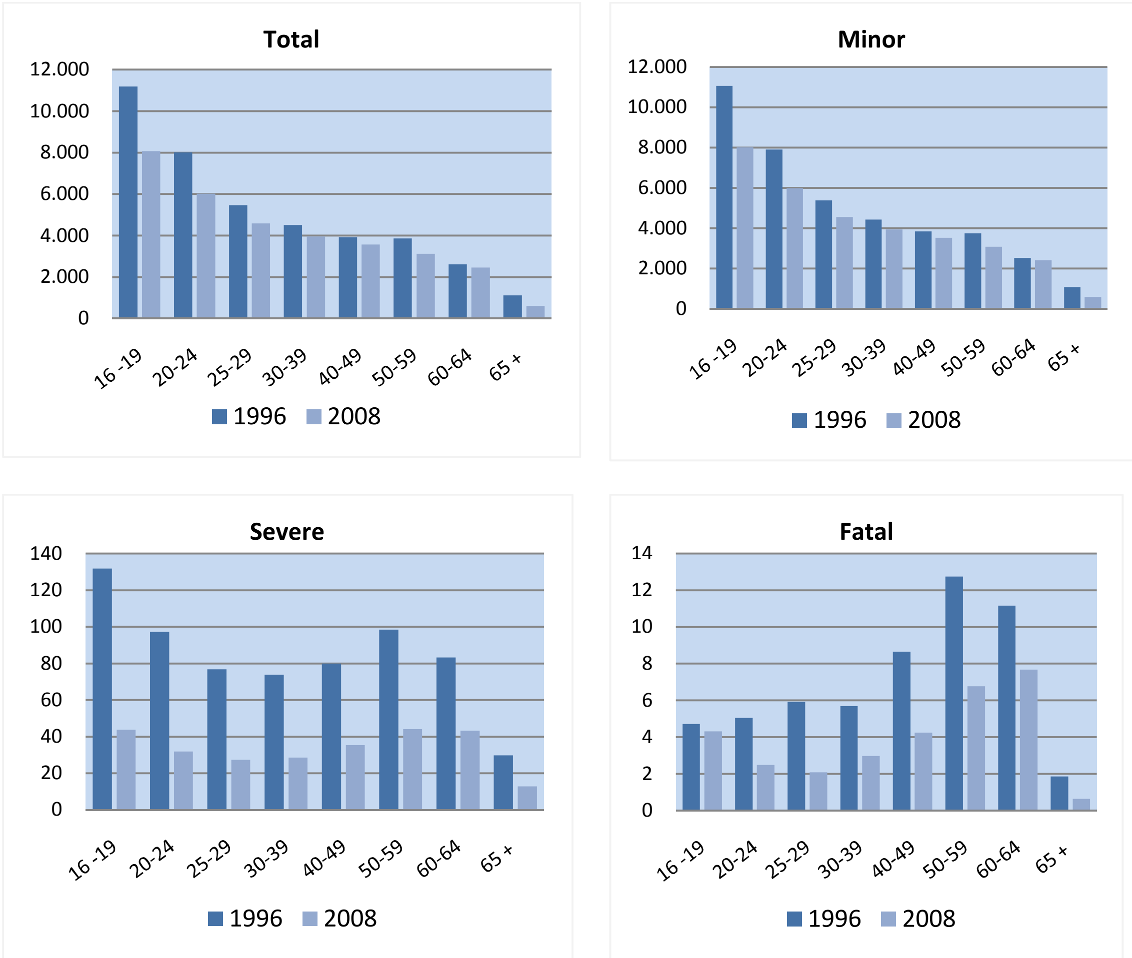
Figure 1. Incidence rates of total, minor, severe and fatal accidents by age groups. 1996 and 2008



Source: own elaboration with data from EAT and EPA

Table 1. Incidence rate of total labour accidents by occupation and age groups. 2008.

	16 -19 years old	20-24 years old	25-29 years old	30-39 years old	40-49 years old	50-59 years old	60-64 years old	65 + years old
Total occupations	**8,067.8**	**6,020.6**	**4,589.3**	**3,960.4**	**3,567.9**	**3,124.6**	**2,462.5**	**599.4**
0 Armed Forces	2,675.0	1,975.4	3,074.3	4,598.6	4,238.2	4,167.9	5,886.8	0.0
1 Managers	1,333.3	313.8	261.5	196.3	167.6	162.6	124.1	52.8
2 Professionals	3,506.2	726.4	501.7	417.9	432.5	492.5	440.8	104.6
3 Technicians and associate professionals	1,777.8	1,376.6	1,089.2	846.1	751.0	715.2	623.1	379.8
4 Clerical support workers	1,880.8	1,583.6	1,491.2	1,410.9	1,353.5	1,207.1	1,194.5	690.4
5 Service and sales workers	4,088.1	3,891.7	3,736.2	3,882.6	3,526.0	3,205.7	2,491.9	821.0
6 Skilled agricultural, forestry and fishery workers	7,562.2	6,541.1	6,128.4	4,494.8	3,847.5	2,789.0	1,568.0	268.3
7 Craft and related trades workers	11,284.6	10,510.2	9,366.4	8,096.2	7,635.2	6,621.4	5,608.7	2,682.4
8 Plant and machine operators, and assemblers	15,204.9	9,648.9	7,820.0	6,701.9	5,739.0	4,792.1	3,726.4	1,635.6
9 Elementary occupations	12,872.3	11,577.1	9,457.4	7,554.4	6,613.1	5,642.0	4,257.7	2,028.4

Source: Elaborated by the authors using data from EAT and EPA

Table 2. Incidence rates of total labour accidents by economic activity and age groups. 2008.

	16 -19 years old	20-24 years old	25-29 years old	30-39 years old	40-49 years old	50-59 years old	60-64 years old	65 + years old
Total economic activities	**8,067.2**	**6,020.8**	**4,589.3**	**3,960.4**	**3,567.9**	**3,124.7**	**2,462.6**	**598.9**
A Agriculture, hunting and forestry	6,645.0	6,475.0	4,472.9	3,670.2	3,564.1	2,672.0	1,636.4	288.2
B Fishing	22,666.7	4,717.9	7,789.5	7,572.4	7,561.0	5,470.1	2,549.5	2,909.1
C Mining and quarrying	18,444.4	9,565.2	11,272.7	17,194.2	14,735.1	6,201.1	3,680.0	750.0
D Manufacturing	13,364.8	9,261.0	7,234.8	5,928.0	5,657.1	4,690.6	3,459.8	722.1
E Electricity, gas and water supply	9,157.9	8,400.0	3,940.9	2,688.6	2,595.4	2,338.9	2,906.7	352.9
F Construction	13,896.1	11,592.1	8,723.1	7,136.4	7,163.3	6,471.8	6,039.1	2,268.7
G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	5,971.8	5,167.0	4,151.7	3,323.3	2,632.4	2,064.5	1,296.4	336.0
H Hotels and restaurants	4,951.0	3,953.3	3,648.0	3,424.3	3,174.0	3,378.9	2,111.6	605.5
I Transport, storage and communication	6,263.6	5,347.0	4,886.8	4,462.0	4,284.6	3,358.7	2,786.9	1,226.4
J Financial Intermediation	823.5	304.5	348.0	323.0	335.4	362.9	198.1	44.9
K Real estate, renting and business activities	11,151.7	5,854.6	3,299.4	2,672.5	2,879.0	3,217.8	2,150.7	564.3
L Public administration and defence; compulsory social security	8,943.3	2,676.3	3,534.7	3,241.5	2,521.0	2,481.3	2,815.4	1,079.1
M Education	3,002.9	1,065.9	627.4	539.4	449.4	489.4	478.7	222.7
N Health and Social Work	4,601.5	2,966.6	2,316.4	2,450.1	2,909.0	2,869.9	2,900.5	723.1
O Other community, social and personal service activities	3,722.8	4,020.8	3,863.5	4,092.7	4,271.8	3,870.0	2,779.9	888.9
P Activities of households	178.3	79.6	81.4	113.8	188.2	206.9	295.5	97.2

Source: Elaborated by the authors using data from EAT and EPA

Table 3. Incidence rates of severe and fatal labour occupational injuries by occupation and age groups. 2008.

	16 -19 years old	20-24 years old	25-29 years old	30-39 years old	40-49 years old	50-59 years old	60-64 years old	65 + years old
Total occupations	**43.8**	**31.9**	**27.4**	**28.6**	**35.4**	**44.1**	**43.2**	**12.9**
0 Armed Forces	25.0	0.0	22.4	28.9	10.8	19.8	0.0	0.0
1 Managers	0.0	5.3	0.0	3.5	3.4	8.2	5.6	4.8
2 Professionals	0.0	3.5	4.7	4.8	6.5	16.0	19.5	2.8
3 Technicians and associate professionals	28.2	13.2	9.1	6.4	9.8	12.0	15.1	16.2
4 Clerical support workers	0.0	2.9	4.1	9.3	11.5	27.7	30.1	60.9
5 Service and sales workers	4.7	8.8	9.3	12.0	17.1	20.7	31.3	0.0
6 Skilled agricultural, forestry and fishery workers	79.6	47.7	50.0	65.9	100.5	103.9	100.3	0.0
7 Craft and related trades workers	75.6	60.6	60.4	72.0	82.5	94.0	85.0	47.1
8 Plant and machine operators, and assemblers	85.0	60.9	66.8	54.1	74.2	74.5	69.1	35.6
9 Elementary occupations	77.8	70.0	54.9	45.5	52.1	61.9	46.9	42.6

Source: Elaborated by the authors using data from EAT and EPA

Table 4. Incidence rates of severe and fatal labour accidents by economic activity and age groups. 2008.

	16 -19 years old	20-24 years old	25-29 years old	30-39 years old	40-49 years old	50-59 years old	60-64 years old	65 + years old
Total economic activities	**43.8**	**31.9**	**27.4**	**28.6**	**35.4**	**44.1**	**43.2**	**12.9**
A Agriculture, hunting and forestry	41.4	43.2	29.0	44.2	77.3	78.2	80.2	0.0
B Fishing	666.7	136.8	210.5	161.5	216.0	179.1	219.8	0.0
C Mining and quarrying	444.4	0.0	99.2	128.4	165.6	212.3	120.0	0.0
D Manufacturing	87.8	50.6	48.0	40.7	48.8	58.6	46.1	12.6
E Electricity, gas and water supply	105.3	22.2	22.2	24.7	26.3	31.4	53.3	0.0
F Construction	108.9	87.7	69.8	74.0	96.2	112.5	108.2	89.6
G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	19.2	13.1	16.6	16.0	18.2	20.5	16.4	6.4
H Hotels and restaurants	15.2	14.8	14.9	9.4	12.0	21.1	25.8	0.0
I Transport, storage and communication	20.7	26.3	28.7	34.0	54.0	63.4	65.6	75.5
J Financial Intermediation	0.0	4.6	0.0	4.4	10.4	16.4	0.0	0.0
K Real estate, renting and business activities	31.0	31.2	10.7	15.6	16.8	28.8	20.2	11.1
L Public administration and defence; compulsory social security	11.9	11.1	15.4	14.5	24.3	35.2	35.1	0.0
M Education	0.0	6.6	1.6	2.1	4.9	5.5	3.9	9.3
N Health and Social Work	0.0	5.5	5.1	12.0	19.2	36.6	64.0	18.3
O Other community, social and personal service activities	25.6	25.9	30.9	27.2	35.7	42.5	40.2	13.5
P Activities of households	0.0	0.0	1.1	1.0	1.0	3.4	5.1	0.0

Source: Elaborated by the authors using data from EAT and EPA

Table 5. Percentage of occupational injuries by description of the accident and age groups. 2008.

	16 - 19 years old		20 - 24 years old		25 - 29 years old		30 - 39 years old		40 - 49 years old		50 - 59 years old		60 - 64 years old		65 + years old	
	%	**Rank**	**%**	**Rank**	**%**	**Rank**	**%**	**Rank**	**%**	**Rank**	**%**	**Rank**	**%**	**Rank**	**%**	**Rank**
Hit caused by a fall	11.1	5	10.9	5	10.8	5	11.3	3	12.6	3	15.8	2	18.4	2	28.0	1
Hit against an immobile object	12.1	4	11.5	4	11.5	4	11.3	4	11.4	4	11.9	4	12.7	4	13.3	4
Hit against a moving object	22.1	2	19.8	2	18.5	2	17.3	2	15.9	2	15.2	3	15.5	3	14.3	3
Contact with electrical current, fire, dangerous temperature and substances	3.7	7	3.6	7	3.5	7	3.4	6	3.2	6	3.0	7	3.0	7	3.4	6
Drowning, burial and "wrapping"	0.3	11	0.3	11	0.4	11	0.4	11	0.3	11	0.3	12	0.3	12	0.2	12
Contact with sharp, hard or abrasive material	15.5	3	13.5	3	11.6	3	10.6	5	9.3	5	8.8	5	9.4	5	8.6	5
Being trapped, flattened, suffer an amputation	4.5	6	3.8	6	3.5	6	3.3	7	3.1	7	3.2	6	3.1	6	2.2	7
Overexertion, psychic trauma, exposure to radiation, noise, light or pressure	27.4	1	33.4	1	36.7	1	38.9	1	40.1	1	37.4	1	32.8	1	25.3	2
Bites, kicks, etc. (by animals or people)	0.9	9	1.0	9	1.2	9	1.3	9	1.2	9	1.1	9	1.2	9	1.5	9
Heart attacks, strokes and other non-traumatic pathologies	0.0	12	0.0	12	0.0	12	0.1	12	0.3	12	0.6	11	0.8	10	0.4	11
Other form of accident	0.7	10	0.7	10	0.7	10	0.8	10	0.8	10	0.9	10	0.8	11	0.5	10
Form of accident doesn't specified	1.7	8	1.5	8	1.5	8	1.5	8	1.7	8	1.9	8	1.9	8	2.2	8
TOTAL	100.0		100.0		100.0		100.0		100.0		100.0		100.0		100.0	

Source: Elaborated by the authors using data from EAT.

Note: Rank indicates the position in the ranking of the description of the accident by frequency; 1 indicates the most common injury; 12 indicate the less common injury.

Table 6. Distribution of occupational injuries according to how the accident happened and the description of the injury. 2008.

Workers aged 16 to 54								
	Superficial injuries	Bone fractures	Sprains and dislocations	Traumatic amputation	Concussions and internal injuries	Multiple injuries	Other injuries	TOTAL
Hit caused by a fall	30.2	13.2	46.3	0.0	5.1	2.5	2.7	100.0
Hit against an immobile object	32.9	8.4	51.0	0.0	4.2	0.8	2.7	100.0
Hit against a moving object	51.6	11.0	26.5	0.1	5.1	2.4	3.3	100.0
Being trapped, flattened, suffer an amputation	48.9	19.7	19.4	2.8	5.1	1.6	2.4	100.0
Overexertion, psychic trauma, exposure to radiation, noise, light or pressure	15.3	1.0	72.2	0.0	6.9	0.2	4.4	100.0
Other form of accident	66.6	2.6	10.7	0.4	1.7	0.7	17.3	100.0
TOTAL	35.9	6.0	45.7	0.2	5.1	1.1	6.1	100.0
Workers aged 55 or more								
	Superficial injuries	Bone fractures	Sprains and dislocations	Traumatic amputation	Concussions and internal injuries	Multiple injuries	Other injuries	TOTAL
Hit caused by a fall	31.6	19.1	37.4	0.0	5.8	2.7	3.4	100.0
Hit against an immobile object	34.9	11.5	43.6	0.1	5.3	1.3	3.3	100.0
Hit against a moving object	51.4	14.1	23.0	0.2	5.2	2.5	3.5	100.0
Being trapped, flattened, suffer an amputation	47.6	22.6	15.5	4.3	4.6	2.5	3.0	100.0
Overexertion, psychic trauma, exposure to radiation, noise, light or pressure	14.6	1.4	71.5	0.0	7.3	0.2	4.9	100.0
Other form of accident	59.6	3.6	11.1	0.6	2.4	1.1	21.7	100.0
TOTAL	34.3	8.7	42.8	0.3	5.6	1.3	7.0	100.0

Source: Elaborated by the authors using data from EAT.

Table 7. Results of the estimation of the determinant factors of the severity of occupational injuries

Number of observations= 797,250					
LRchi2(98)= 30,258.93					
Prob>chi2= 0					
Pseudo R2 = 0.3313					
			Marginal effects		
Variable	Coefficient	Standar Error	∂P(Y=1)/∂X	∂P(Y=2)/∂X	∂P(Y=3)/∂X
Sex (ref. man)					
Woman	0.247***	0.019	-0.00095	0.00093	0.00002
Age (ref. 16-19 years old)					
20-24 years old	0.031	0.040	-0.00015	0.00015	0.00000
25-29 years old	0.096**	0.038	-0.00049	0.00048	0.00001
30-39 years old	0.148***	0.037	-0.00074	0.00073	0.00001
40-49 years old	0.240***	0.037	-0.00135	0.00132	0.00003
50-59 years old	0.322***	0.038	-0.00215	0.00210	0.00005
60-64 years old	0.346***	0.044	-0.00264	0.00258	0.00006
65 or more	0.323***	0.119	-0.00244	0.00238	0.00006
Region (ref. Andalucía)					
Aragón	-0.224***	0.038	0.00075	-0.00074	-0.00001
Asturias	-0.155***	0.038	0.00057	-0.00056	-0.00001
Baleares	-0.139***	0.037	0.00053	-0.00052	-0.00001
Canarias	-0.237***	0.033	0.00080	-0.00078	-0.00001
Cantabria	-0.018	0.045	0.00008	-0.00008	0.00000
Castilla La Mancha	-0.081***	0.027	0.00033	-0.00033	0.00000
Castilla y León	-0.080***	0.026	0.00033	-0.00032	-0.00001
Cataluña	-0.010	0.025	0.00005	-0.00005	0.00000
Comunidad Valenciana	-0.124***	0.021	0.00049	-0.00048	-0.00001
Extremadura	0.050	0.036	-0.00024	0.00024	0.00000
Galicia	0.018	0.022	-0.00008	0.00008	0.00000
Madrid	-0.211***	0.022	0.00078	-0.00077	-0.00001
Murcia	-0.131***	0.036	0.00050	-0.00049	-0.00001
Navarra	-0.050	0.044	0.00021	-0.00021	0.00000
País Vasco	-0.189***	0.029	0.00067	-0.00066	-0.00001
La Rioja	-0.271***	0.077	0.00084	-0.00083	-0.00001
Ceuta y Melilla	-0.057	0.113	0.00024	-0.00024	0.00000
Economic activity (ref. Fishing)					
A Agriculture, hunting and forestry	-0.124**	0.056	0.00048	-0.00047	-0.00001
C Mining and quarrying	-0.052	0.078	0.00022	-0.00022	0.00000
D Manufacturing	-0.223***	0.059	0.00087	-0.00085	-0.00002
E Electricity, gas and water supply	-0.314***	0.098	0.00092	-0.00091	-0.00001
F Construction	-0.185***	0.059	0.00074	-0.00073	-0.00001
G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	-0.315***	0.060	0.00105	-0.00103	-0.00002
H Hotels and restaurants	-0.349***	0.066	0.00104	-0.00102	-0.00002
I Transport, storage and communication	-0.271***	0.061	0.00089	-0.00087	-0.00002
J Financial Intermediation	-0.239**	0.107	0.00077	-0.00076	-0.00001
K Real estate, renting and business activities	-0.293***	0.062	0.00095	-0.00093	-0.00002
L Public administration and defence; compulsory social security	-0.240***	0.063	0.00080	-0.00079	-0.00001
M Education	-0.357***	0.091	0.00100	-0.00098	-0.00002
N Health and Social Work	-0.178***	0.068	0.00064	-0.00063	-0.00001
O Other community, social and personal service activities	-0.163**	0.063	0.00060	-0.00059	-0.00001
P Activities of households	-0.462***	0.154	0.00112	-0.00110	-0.00002
Q Extra-territorial organizations and bodies	-0.335	0.438	0.00095	-0.00094	-0.00001

Table 7. (Continuation)

Variable	Coefficient	Standar Error	Marginal effects ∂P(Y=1)/∂X	∂P(Y=2)/∂X	∂P(Y=3)/∂X
Occupation (ref. Managers)					
Armed Forces	-0.292**	0.124	0.00088	-0.00087	-0.00001
Professionals	0.094	0.077	-0.00049	0.00048	0.00001
Technicians and associate professionals	0.019	0.072	-0.00009	0.00009	0.00000
Clerical support workers	-0.107	0.073	0.00042	-0.00041	-0.00001
Service and sales workers	-0.179**	0.069	0.00068	-0.00067	-0.00001
Skilled agricultural, forestry and fishery workers	0.094	0.074	-0.00050	0.00049	0.00001
Craft and related trades workers	-0.083	0.067	0.00037	-0.00036	-0.00001
Plant and machine operators, and assemblers	-0.047	0.067	0.00021	-0.00020	-0.00001
Elementary occupations	-0.096	0.067	0.00041	-0.00040	-0.00001
Number employees of the firm (ref. 1 - 5 employees)					
6-10 employees	-0.088***	0.020	0.00036	-0.00035	-0.00001
11-25 employees	-0.113***	0.017	0.00046	-0.00046	-0.00001
26-50 employees	-0.153***	0.019	0.00060	-0.00059	-0.00001
51-100 employees	-0.202***	0.021	0.00074	-0.00073	-0.00001
101-500 employees	-0.231***	0.020	0.00087	-0.00086	-0.00002
501-1000 employees	-0.281***	0.035	0.00090	-0.00088	-0.00002
More than 1000 employees	-0.239***	0.030	0.00082	-0.00080	-0.00001
Kind of contract (ref. Fixed-term contract)					
Permanent contract	-0.058***	0.012	0.00027	-0.00026	-0.00001
Place of accident (ref. In habitual workplace)					
Travel during working day	0.263***	0.019	-0.00173	0.00169	0.00004
In other workplace	0.346***	0.018	-0.00256	0.00250	0.00006
Working hour of accident (ref. 1, 2 or 3)					
4, 5 or 6	0.015	0.013	-0.00007	0.00007	0.00000
7, 8 or 9	0.029*	0.016	-0.00014	0.00014	0.00000
10, 11 or 12	-0.063**	0.028	0.00027	-0.00026	-0.00001
13, 14 or 15	0.096**	0.042	-0.00050	0.00049	0.00001
16, 17 or 18	0.022	0.040	-0.00010	0.00010	0.00000
19, 20 or 21	0.090	0.064	-0.00047	0.00046	0.00001
22, 23 or 24	-0.103	0.099	0.00041	-0.00040	-0.00001
Hour of accident (ref. From 8 am to 8 pm)					
From 8pm to 8am	0.059***	0.017	-0.00029	0.00028	0.00001
Non-regular job	0.165***	0.025	-0.00095	0.00093	0.00002
Part of body injured (ref. Head)					
Neck	-0.484***	0.047	0.00121	-0.00119	-0.00002
Back	-0.424***	0.028	0.00138	-0.00136	-0.00002
Trunk and organ	-0.280***	0.026	0.00089	-0.00087	-0.00002
Upper extremities	-0.677***	0.020	0.00268	-0.00263	-0.00005
Lower extremities	-0.379***	0.020	0.00141	-0.00138	-0.00003
All body and numerous parts	0.170***	0.025	-0.00100	0.00098	0.00002
Other parts of the body	0.062	0.048	-0.00031	0.00030	0.00001

Table 7. (Continuation)

Variable	Coefficient	Standar Error	Marginal effects ∂P(Y=1)/∂X	∂P(Y=2)/∂X	∂P(Y=3)/∂X
Description of the injury (ref. Superficial injuries)					
Bone fractures	1.269***	0.017	-0.03492	0.03311	0.00181
Sprains and dislocations	0.006	0.022	-0.00003	0.00003	0.00000
Traumatic amputation	1.979***	0.038	-0.15371	0.13684	0.01686
Concussions and internal injuries	0.813***	0.022	-0.01204	0.01162	0.00042
Burns and frozen	0.929***	0.041	-0.01773	0.01702	0.00071
Poisoning and infections	0.406***	0.108	-0.00349	0.00340	0.00009
Drowning and asphyxias	0.098	0.104	-0.00052	0.00051	0.00001
Effects of noise, vibration or pressure	0.362*	0.205	-0.00290	0.00282	0.00007
Effects of extreme temperatures, light and radiation	0.522***	0.178	-0.00539	0.00524	0.00015
Psychological trauma, traumatic shock	1.081***	0.075	-0.02666	0.02541	0.00125
Multiple injuries	1.210***	0.026	-0.03519	0.03334	0.00184
Heart attacks, strokes and other non-traumatic pathologies	2.693***	0.351	-0.37993	0.30068	0.07924
Other injuries	0.518***	0.035	-0.00517	0.00503	0.00015
How the accident happened (ref. Contact with electrical current, fire, dangerous temperature and substances)					
Drowning, burial, "wrapping"	0.451***	0.093	-0.00415	0.00403	0.00011
Hit against an immobile object	-0.124***	0.035	0.00049	-0.00048	-0.00001
Hit caused by a fall	0.269***	0.032	-0.00170	0.00166	0.00004
Hit against a moving object	0.048	0.031	-0.00023	0.00023	0.00000
Contact with sharp, hard or abrasive material	0.358***	0.034	-0.00256	0.00250	0.00006
Being trapped, flattened, suffer an amputation	0.558***	0.035	-0.00583	0.00566	0.00017
Overexertion, psychic trauma, exposure to radiation, noise, light or pressure	-0.405***	0.037	0.00168	-0.00165	-0.00003
Bites, kicks, etc. (by animals or people)	0.004	0.051	-0.00002	0.00002	0.00000
Heart attacks, strokes and other non-traumatic pathologies	0.052	0.352	-0.00026	0.00025	0.00001
Other form of accident	-0.078	0.068	0.00032	-0.00031	-0.00001
/cut1	2.46				
/cut2	3.57				

Note: *, **, *** indicate that the coefficient is significant at 10, at 5 and at 1%, respectively.

Table 8. Results of the estimation of the determinant factors of the duration sick leave caused by occupational injuries

Number of observations= 796,445			
Number of failures= 677,991			
LRchi2(101)= 131,511.63			
Prob>chi2= 0			
Variable	**Coefficient B**	**Standard Error**	**ExpB**
Sex (ref. man)			
Woman	-0.056***	0.003	0.945
Age (ref. 16-19 years old)			
20-24 years old	-0.096***	0.007	0.908
25-29 years old	-0.213***	0.007	0.808
30-39 years old	-0.323***	0.007	0.724
40-49 years old	-0.415***	0.007	0.660
50-59 years old	-0.517***	0.008	0.596
60-64 years old	-0.588***	0.011	0.556
65 or more	-0.601***	0.038	0.548
Length of service in the firm	-0.000***	0.000	1.000
Region (ref. Andalucía)			
Aragón	-0.163***	0.008	0.849
Asturias	-0.234***	0.008	0.791
Baleares	0.018**	0.008	1.018
Canarias	-0.004	0.006	0.996
Cantabria	-0.215***	0.012	0.806
Castilla La Mancha	-0.057***	0.006	0.945
Castilla y León	-0.117***	0.006	0.890
Cataluña	-0.035***	0.006	0.966
Comunidad Valenciana	-0.152***	0.005	0.859
Extremadura	0.017*	0.009	1.017
Galicia	-0.189***	0.006	0.828
Madrid	-0.041***	0.004	0.960
Murcia	-0.282***	0.008	0.754
Navarra	0.023**	0.010	1.023
País Vasco	-0.023***	0.006	0.977
La Rioja	0.004	0.015	1.004
Ceuta y Melilla	-0.294***	0.029	0.745
Economic activity (ref. Fishing)			
A Agriculture, hunting and forestry	0.104***	0.021	1.110
C Mining and quarrying	0.195***	0.025	1.215
D Manufacturing	0.238***	0.022	1.268
E Electricity, gas and water supply	0.225***	0.028	1.253
F Construction	0.195***	0.022	1.216
G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	0.268***	0.022	1.307
H Hotels and restaurants	0.212***	0.022	1.236
I Transport, storage and communication	0.205***	0.022	1.228
J Financial Intermediation	0.280***	0.034	1.323
K Real estate, renting and business activities	0.263***	0.022	1.301
L Public administration and defence; compulsory social security	0.208***	0.022	1.232
M Education	0.305***	0.026	1.356
N Health and Social Work	0.067***	0.022	1.070
O Other community, social and personal service activities	0.205***	0.022	1.227
P Activities of households	0.191***	0.039	1.210
Q Extra-territorial organizations and bodies	0.310***	0.097	1.363

Table 8. (Continuation)

Variable	Coefficient B	Standard Error	ExpB
Occupation (ref. Managers)			
Armed Forces	0.206***	0.029	1.229
Professionals	0.050**	0.025	1.051
Technicians and associate professionals	0.104***	0.023	1.109
Clerical support workers	0.190***	0.023	1.209
Service and sales workers	0.153***	0.022	1.165
Skilled agricultural, forestry and fishery workers	0.111***	0.024	1.117
Craft and related trades workers	0.184***	0.022	1.202
Plant and machine operators, and assemblers	0.171***	0.022	1.186
Elementary occupations	0.164***	0.022	1.178
Number employees of the firm (ref. 1 - 5 employees)			
6-10 employees	0.103***	0.005	1.109
11-25 employees	0.127***	0.005	1.136
26-50 employees	0.141***	0.005	1.151
51-100 employees	0.150***	0.005	1.162
101-500 employees	0.149***	0.005	1.161
501-1000 employees	0.117***	0.007	1.124
More than 1000 employees	0.061***	0.006	1.063
Kind of contract (ref. Fixed-term contract)			
Permanent contract	0.054***	0.003	1.055
Kind of accident (ref. Minor accident)			
Severe accident	-1.678***	0.018	0.187
Place of accident (ref. In habitual workplace)			
Travel during working day	-0.171***	0.006	0.843
In other workplace	-0.011**	0.006	0.989
Working hour of accident (ref. 1, 2 or 3)			
4, 5 or 6	-0.007**	0.003	0.993
7, 8 or 9	-0.002	0.004	0.998
10, 11 or 12	-0.004	0.006	0.996
13, 14 or 15	-0.041***	0.010	0.960
16, 17 or 18	-0.022**	0.009	0.978
19, 20 or 21	-0.039***	0.015	0.962
22, 23 or 24	-0.056***	0.020	0.946
Hour of accident (ref. From 8 am to 8 pm)			
From 8pm to 8am	-0.021***	0.004	0.979
Non-regular job	-0.031***	0.007	0.970
Part of body injured (ref. Head)			
Neck	-0.538***	0.008	0.584
Back	-0.409***	0.006	0.664
Trunk and organ	-0.452***	0.008	0.636
Upper extremities	-0.634***	0.005	0.531
Lower extremities	-0.634***	0.006	0.531
All body and numerous parts	-0.675***	0.010	0.509
Other parts of the body	-0.612***	0.020	0.542

Table 8. (Continuation)

Variable	Coefficient B	Standard Error	ExpB
Description of the injury (ref. Superficial injuries)			
Bone fractures	-1.008***	0.006	0.365
Sprains and dislocations	-0.144***	0.003	0.866
Traumatic amputation	-1.133***	0.030	0.322
Concussions and internal injuries	-0.225***	0.006	0.799
Burns and frozen	0.004	0.012	1.004
Poisoning and infections	0.155***	0.029	1.167
Drowning and asphyxias	0.232***	0.037	1.261
Effects of noise, vibration or pressure	-0.169***	0.036	0.844
Effects of extreme temperatures, light and radiation	0.607***	0.051	1.836
Psychological trauma, traumatic shock	-0.651***	0.032	0.521
Multiple injuries	-0.487***	0.013	0.614
Heart attacks, strokes and other non-traumatic pathologies	-2.613***	0.707	0.073
Other injuries	-0.117***	0.009	0.890
How the accident happened (ref. Contact with electrical current, fire, dangerous temperature and substances)			
Drowning, burial, "wrapping"	0.049	0.037	1.050
Hit against an immobile object	-0.061***	0.008	0.941
Hit caused by a fall	-0.227***	0.008	0.797
Hit against a moving object	-0.076***	0.007	0.926
Contact with sharp, hard or abrasive material	0.024***	0.008	1.024
Being trapped, flattened, suffer an amputation	-0.156***	0.010	0.856
Overexertion, psychic trauma, exposure to radiation, noise, light or pressure	-0.069***	0.007	0.933
Bites, kicks, etc. (by animals or people)	-0.049***	0.013	0.953
Heart attacks, strokes and other non-traumatic pathologies	1.269*	0.708	3.557
Other form of accident	-0.051***	0.015	0.950

Note: *, **, *** indicate that the coefficient is significant at 10, at 5 and at 1%, respectively.