


# BMJ Open Description of the epidemiological characteristics of work-related eye injuries in Spain: a retrospective study

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## ABSTRACT

**Objective** To describe the epidemiological characteristics and trends of work-related eye injuries (WREIs) in Spain over a 10-year period by sex, age and occupational sector.

**Design and settings** A descriptive, retrospective and longitudinal study based on data from workers insured by a labour insurance company in Spain from 2008 to 2018 was presented. The study considered the ratio of the number of WREI per 100 000 population and the relative risk of suffering an ocular injury. WREIs were characterised by sex, age and occupational sector of injured workers.

**Primary and secondary outcome measures** Ratio of the number of WREI.

**Participants** In Spain, all workers are insured by a labour insurance company that provides cover in the event of work-related accidents. In this study, we have included all workers insured by one of these insurance companies, IBERMUTUA, with workers in all areas of Spain.

**Results** The study included 50 265 WREI in the company over the 10-year period. Most of the injuries occurred in males (44 445; 88.4%), in 35–44 age group (15 992; 31.8%) and in industry workers (18 899; 42.6%). The average incidence was 429.75 per 100 000 workers insured and 4273.36 per 100 000 IBERMUTUA accidents (related and not related to eyes). Males, 16–24 age group and industry occupational sector group, have the highest incidence for WREI. The incidence of WREI decrease over the study period in all variables. Males have 6.56 (95% CI 6.38 to 6.75) times more risk of suffering WREI than females. 16–24 age group have 1.77 (95% CI 1.71 to 1.83) times more risk than in the group of workers older than 55. Finally, industry workers have 7.73 (95% CI 7.55 to 7.92) times more risk than services workers.

**Conclusions** The risks of suffering WREI is higher for males, younger and less experienced workers, and for those who works in a manual task.

## INTRODUCTION

An accident at work is defined in European Statistics on Accidents at Work methodology as a discrete occurrence during the course of work which leads to physical or mental harm.<sup>1</sup> According to the Labour Force Survey, 6.9 million accidents at work occurred in the European Union in 2007, affecting 3.2% of the population.<sup>2</sup> In 2017, a total of

## Strengths and limitations of this study

- Data are collected from Ibermutua, one of the largest mutual insurance companies in Spain.
- This study has the highest number of workers in a research across Europe.
- This study covers a 10-year period, including an economic crisis during the period studied.
- Data are collected from only one mutual insurance company.
- Economic activities have been classified according to 2009 National Economic Activities Code and not divided into specific groups.

1.33 million of these accidents occurred in Spain, affecting 2.86% of the population.<sup>3</sup> Within these statistics, work-related eye injuries (WREI) caused 16245 workers to be absent from work in 2017 and the eye was the most affected structure in the head.

The prevalence of ocular injuries in developed countries ranges from 88 to 1920 out of a 100 000 population,<sup>4,5</sup> depending on the origin and the type of ocular injury. León Hernández *et al*<sup>6</sup> found that 20.2% of all ocular traumas in Spain in 1991 occurred in the workplace. The percentage of ocular injuries related to work changes along with the world from 0.84% to 3.4%.<sup>7–9</sup> It depends on the type of population, the medical attention and the type of injury included in the study.

The universal plan of ocular health established by WHO for the period 2014–2019, has as a main goal decreasing vision impairment around the world.<sup>7</sup> One of their secondary objectives is the generation of scientific data about the magnitude and causes of vision impairment in order to follow the progress and could define priorities. WREIs are one of these lesions related to vision impairment. Due to the characteristics of these injuries, they could be prevented by the creation of specific plans that just could be defined

through the knowledge about the epidemiology and mechanism of WREI.

The main objective of this study was the epidemiological characterisation of WREI causing ocular injury in Spain by sex, age and occupational sectors over a 10-year period.

## METHODS

A descriptive, retrospective and longitudinal study was performed. We analysed WREIs that affect any ocular structure during work time in a mutual insurance company. Study data were provided by IBERMUTUA, a mutual insurance company that collaborates with the Spanish Social Security system. Mutual insurance companies are non-profit private associations of business owners which are duly authorised by the Spanish Ministry of Employment and Social Security and registered with the Special Register operated by the said ministry. They aim to collaborate with the management of the Spanish Social Security system under its direction and auspices with members jointly assuming liability for the situations and with the scope established by the law. On these companies, medical specialists evaluate work accidents reported by the companies it insures, analysing the work-related injury and its consequences for insured workers. The study period was from 1 January 2008 to 31 December 2018.

The area of study covered all regions in Spain including Ceuta and Melilla with a population of 46 650 300 in 2018<sup>7</sup> (latest census). In these years, we analysed 11 696 259 subjects (table 1), all of them IBERMUTUA-insured workers during the study period, and we related them to 201 167 800 workers in Spain.<sup>8</sup>

All medical records were anonymous; only statistical information was provided by Ibermutua for research purposes.

### Inclusion criteria

We studied WREIs that affect any ocular structure during work time and in itinere. These injuries were evaluated and classified by medical specialists according to Clasificación Internacional de Enfermedades, 9th revisión, Modificación Clínica (CIE-9-MC) classification, correlations with Classification of diseases 10th version (ICD-10) that's is the new classification. According to WHO, ICD is the foundation for the identification of health trends and statistics globally, and the international standard for reporting diseases and health conditions. This allows making data comparisons in the same location across different periods. Ocular injuries are included in this classification with codes from 360 to 379. Only injuries where any ocular structure was affected as the main injury were included in the study.

We analysed sex (males and females), age and occupational sector. We established five age groups (16–24, 25–34, 35–44, 45–54 and ≥55) according to the Labour, Migrations and Social Security Ministry of Spain.<sup>3</sup> The

**Table 1** Total cases (N) of Ibermutua-insured, Ibermutua accidents and total work-related eye injuries (WREI) according to sex, age and workers occupation

	Total		Losses	
	N	%	N	%
Ibermutua insured	11 696 259			
Ibermutua accidents	1 179 067			
Spanish workers	201 167 800			
WREI	50 265			
Sex WREI				
Male	44 445	89.3		
Female	5349	10.7		
Total	49 794	100	471	0.9
Age group WREI				
16–24	4388	8.8		
25–34	14 981	29.9		
35–44	15 992	32.0		
45–54	10 278	20.5		
>55	4390	8.8		
Total	50 029	100	236	0.5
Occupation WREI				
Agriculture	1624	3.7		
Industry	18 899	42.6		
Construction	10 455	23.6		
Services	13 394	30.2		
Total	44 369	100	5893	11.7

Losses: total number of losses out of total number of cases (50 265) of WREI in all different groups.

occupational sector was classified according to the same Ministry's 2009 National Economic Activities Code (in Spanish), whereby occupational sector was divided into four groups: agricultural, industry, construction and services.<sup>3</sup>

### Statistical analysis

Quantitative variables are given as a mean±SD. For qualitative variables, absolute and relative frequencies are given in percentages. To standardise data, the relationship between the number of WREI per 100 000 population in Ibermutua (ratio/100 000 population) was calculated. Ibermutua data were divided into Ibermutua insured, which are the total number of workers insured by IBERMUTUA and IBERMUTUA accidents. Accidents refer to all the workers insured by Ibermutua that have suffered an accident in the 10-year period studied. A relative risk (RR) was computed to check the effects that exist between different groups of sex, age and occupational sector. To compare different groups in each variable, the lowest incidence per 100 000 population on each group was considered as reference. RR shows how many times more of risk have a worker to suffer an accident respect the reference.

A multiple logistic regression has been used to analyse the relationship between WREI and sex, age and occupation. The risk of suffering WREI was calculated from the OR obtained on this analysis taking as the reference the group with the lowest incidence.

The  $\chi^2$  test and the Fisher's exact test were used to analyse qualitative variables. The student's t-test and the Mann-Whitney U-test were used, as appropriate, to search for significant differences between preferences.

The statistical analysis was performed using SPSS, V.21.0 (IBM), with  $p < 0.05$  considered significant for all analyses.

### Patient and public involvement

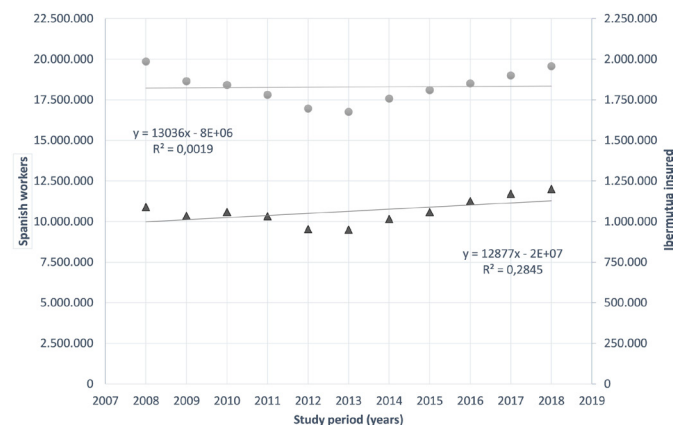
No patient involved.

## RESULTS

There were 50 265 WREI in Ibermutua over the 10-year period (table 1). These accidents affected 0.45% of all workers insured by IBERMUTUA and represented 4.22% of all accidents suffered by Ibermutua-insured workers (1 179 067 total accidents (table 1)). The average age was  $38.62 \pm 10.57$  and the majority of all injuries occurred in the 35–44 age group (15 992; 32.0%). Within the subject population, 44 445 were male (89.3%) and 5349 females (10.7%), and industry workers were the most affected group (18 899, 42.6%) (table 1).

The incidence of WREI was 429.75/100 000 Ibermutua-insured workers and the incidence of WREI among Ibermutua-insured accidents was 4273.36/100 000.

Workers insured by Ibermutua constituted an average of 5.81% (SD  $\pm 0.221$ ) of all workers in Spain, and the rate of change between workers insured in Ibermutua and total workers in Spain in the study period did not show statistically significant differences ( $p = 0.9987$ ) (figure 1). This rate of change did not show statistically significant differences in services ( $p = 0.070$ ) and industry ( $p = 0.453$ ). The decrease in Spanish construction workers was statistical significance higher ( $p = 0.009$ ) than Ibermutua construction insured over the study period, however, the



**Figure 1** Relation between Ibermutua insured (triangle line) and Spanish workers (circle line) over the study period. There were no statistically significant differences in evolution over the 2008–2018 period ( $p = 0.9987$ ).

trend is very similar. This trend was statistical significance different ( $p = 0.02$ ) in agriculture where Spanish workers decrease against Ibermutua insured who increased its number.

### Incidence and RR per 100 000 Ibermutua insured

The incidence of WREI over the 10-year period was 680.12 per 100 000 insured for males and 103.63 per 100 000 insured for females. Therefore, males had 6.56 (95% CI 6.38 to 6.75) times more RR of suffering WREI than females (table 2). If we analyse the evolution over the study period, a decrease in the incidence in both groups was observed. This decrease was statistically significant bigger in males than females ( $p = 0.00027$ ) (figure 2A).

The highest incidence by age group corresponds to the 16–24 group (561.16). The incidence decreases with age, 487.27 in 25–34, 435.57 in 35–44, 369.42 in 45–54, and 316.69 in  $\geq 55$  group (table 2). The  $\geq 55$  age group is the reference for calculating the RR of suffering a WREI in the other groups because it is the group with the lowest incidence. In this case, RR decreases with age in the same way as the incidence (1.77 (95% CI 1.71 to 1.83), 1.54 (95% CI 1.51 to 1.57), 1.38 (95% CI 1.35 to 1.41) and 1.17 (95% CI 1.13 to 1.21)) (table 2). Over the study period, a decrease in the incidence of WREI in all age groups was observed, and it was statistically significant ( $p < 0.05$ ) when we compared 16–24 age group with the other groups, as well as when we compared 25–34 age group with 45–54 age group ( $p = 0.035$ ) and 25–34 age group with  $\geq 55$  age group ( $p = 0.021$ ) (figure 2B).

Industry workers were the occupation group with the highest incidence of WREI (1538.17), followed by construction workers (1381.52), agriculture workers (479.65) and, finally, services workers (198.92) (table 2). Therefore, in comparison with services workers, the risk of suffering an accident (RR) is 7.73 (95% CI 7.55 to 7.92) times higher in Industry workers, 6.94 (95% CI 6.77 to 7.12) times higher in construction workers, and 1.53 (95% CI 1.45 to 1.61) times higher in agriculture workers (table 2). A decrease in incidence was observed in all occupation groups over the period. There were statistically significant differences ( $p < 0.05$ ) when we compared all groups with each other, except for the two groups with the highest incidence, industry workers and construction workers ( $p = 0.827$ ) (figure 2C).

### Incidence and RR per 100 000 Ibermutua accidents

WREI incidence was 5125.26 for males and 1762.18 for females, with an RR 2.91 (95% CI 2.83 to 2.99) higher in males (table 2). Incidence throughout the period decreases over time and is statistically significantly higher in males ( $p < 0.001$ ) than females (figure 3A).

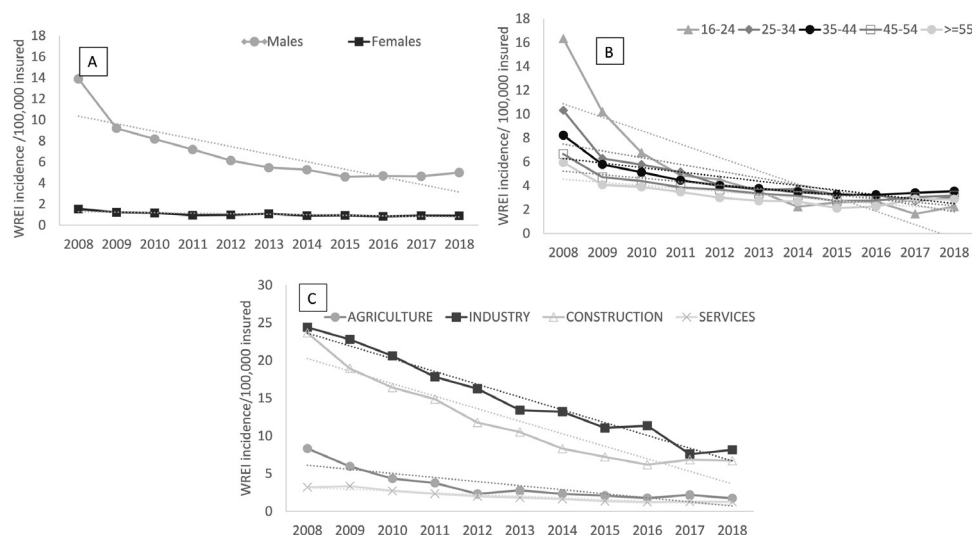
In the same way as when we compared the incidence per 100 000 Ibermutua insured, incidence and RR decrease with age. We observed the highest incidence and RR in 16–24 age group (5083.64 and RR 1.51 (95% CI 1.46 to 1.56)), followed by 25–34 age group (4800.23 and RR 1.43 (95% CI 1.40 to 1.46)), 35–44 age group

**Table 2** Incidence of WREI over 100 000 insured and 1 000 000 accidents and relative risk (RR) of work-related eye injuries (WREI) over a 10-year period according to sex, age and sector

	WREI incidence per 100 000 accidents	Risk percentage of WREI (%)	WREI incidence per 100 000 accidents	RR WREI according to insured		RR WREI according to accidents	
				RR	95% CI	RR	95% CI
<b>Sex</b>							
Total	425.73		4253.29				
Male	680.13	80.11% (95% CI 79.61% to 80.61%)	5125.27	6.56	6.38 to 6.75	2.91	2.83 to 2.99
Female	103.63	REF	1762.19	REF		REF	
<b>Age</b>							
Total	427.74		4273.36				
16–24 years	561.16	64.15% (95% CI 63.11% to 65.19%)	5083.65	1.77	1.71 to 1.83	1.51	1.46 to 1.56
25–34 years	487.27	60.79% (95% CI 59.93% to 61.65%)	4800.23	1.54	1.51 to 1.57	1.43	1.40 to 1.46
35–44 years	435.58	58.24% (95% CI 57.37% to 59.11%)	4364.94	1.38	1.35 to 1.41	1.30	1.27 to 1.33
45–54 years	369.43	55.45% (95% CI 54.50% to 56.39%)	3729.40	1.17	1.13 to 1.21	1.11	1.07 to 1.15
>55 Years	316.69	REF	3368.01	REF		REF	
<b>Occupation</b>							
Total	479.65		4719.61				
Agriculture	305.14	53.50% (95% CI 52.33% to 54.93%)	4495.75	1.53	1.45 to 1.61	1.72	1.64 to 1.81
Industry	1538.18	85.29% (95% CI 85.00% to 85.57%)	8050.69	7.73	7.55 to 7.92	3.83	3.74 to 3.92
Construction	1381.53	80.85% (95% CI 80.43% to 81.26%)	6650.00	6.94	6.77 to 7.12	2.54	2.48 to 2.60
Services	198.92	REF	2615.65	REF		REF	

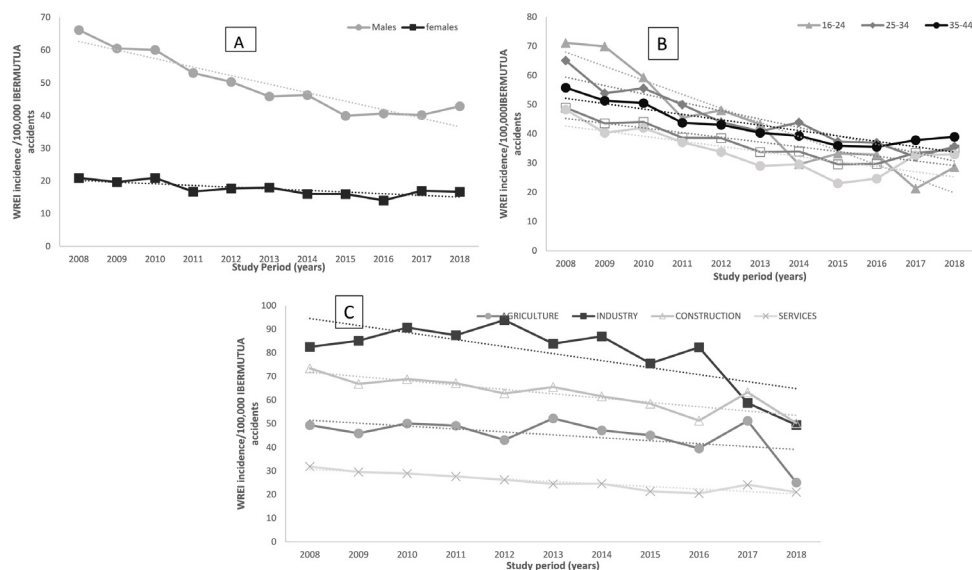
(4364.93 and RR 1.30 (95% CI 1.27 to 1.33)), 45–54 years group (3729.39 and RR 1.11 (95% CI 1.07 to 1.15)), and, used as a reference and with the lowest incidence of all,

the  $\geq 55$  age group (3368.01). WREI incidence decreased in all age groups over time, and there was a statistically significant ( $p < 0.05$ ) decrease when we compared 16–24



**Figure 2** Evolution of WREI incidence per 100 000 Ibermutua insured over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed. WREI, work-related eye injuries.





**Figure 3** Evolution of WREI incidence per 100 000 Ibermutua accidents over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed. WREI, work-related eye injuries.

and 25–34 age groups with each other and both groups with the other groups (figure 3B).

Industry workers suffer the highest incidence and RR of WREI in the four occupation groups (8050.69; RR 3.83 (95% CI 3.74 to 3.92)), followed by construction workers (6650; RR 2.54 (95% CI 2.48 to 5.60)), agriculture workers (4495.75; RR 1.72 (95% CI 1.64 to 1.81)), and, with the lowest incidence and RR of all, services workers (2615.64), the latter therefore being reference group for RR. Although we observed a decrease in incidence over the period, it was not statistically significant when we compared different groups (figure 3C).

### Interaction analysis between sex, age and occupation

Table 3 shows how according to the the results of the multiple logistic regression analysis, there was significant relationship between WREI and sex, age and occupation. Males had 80.11% (95% CI 79.61% to 80.61%) more risk of suffering WREI than females. In addition, 16–24 age group showed the highest risk of suffering WREI compared with the lowest group (>55 years) (64.15% (95% CI 63.11% to 65.19%)) and followed by the 25–34 age group (60.79% (95% CI 59.93% to 61.65%)), the 35–44 age group (58.24% (95% CI 57.37% to 59.11%)) and the 45–54 age group (55.45% (95% CI 54.50% to 56.39%)).

Workers from the industry group had the highest risk of suffering WREI compared with those from the services group (85.29% (95% CI 85.00% to 85.57%)). They were followed by workers from the construction (80.85% (95% CI 80.43% to 81.26%)) and agriculture sectors (53.50% (95% CI 52.33% to 54.93%)).

Table 3 Relationship between WREI and study variables according to multivariate logistic regression analysis		
	OR (95% CI)	P value
<b>Sex</b>		
Male	4030 (3904 to 4159)	<0001
Female	REF	REF
<b>Age (years)</b>		
16–24 years	1790 (1711 to 1873)	<0001
25–34 years	1551 (1496 to 1608)	<0001
35–44 years	1395 (1346 to 1446)	<0001
45–54 years	1245 (1198 to 1293)	<0001
>55 Years	REF	REF
<b>Occupation</b>		
Agriculture	1151 (1098 to 1219)	<0001
Industry	4222 (4111 to 4336)	<0001
Construction	5799 (5668 to 5933)	<0001
Services	REF	REF

WREI, work-related eye injuries.

### DISCUSSION

Of all the long-term studies, we have observed in Europe, this is the one which covers the largest area and the highest number of cases. The close relationship between Ibermutua-insured workers and the evolution in the number of workers in Spain ( $p=0.9987$ ) indicates the importance of our data analysis. The highest WREI incidence per 100 000 Ibermutua insured/accidents and the highest RR was observed in males, aged between 16 and 24 that worked in the industry sector. The evolution of WREI incidence per 100 000 insured/accidents over the study period showed a decrease in all the groups (both sexes and all ages and sectors).

The percentage of WREI in our study was lower than Gómez Villa *et al*<sup>9</sup> observed in two villages on the island



of Mallorca (Spain) (0.84%) Torino (Italy) (1.3%)<sup>10</sup> and much lower than another with a similar number of study cases in the USA (3.4%).<sup>11</sup> The difference was maybe due to the smaller area and population (only two villages and 50851 workers) and the shorter study period (2years) in Mallorca and the population in the USA and Torino is not only insured workers.

The total incidence of WREI falls between the values of other studies<sup>4 5</sup> and is very similar to that found by Karlson and Klein<sup>12</sup> in Wisconsin (USA) in 1986 (423/100 000). However, in all of these studies, the incidence does not relate exclusively to work-related injuries. If we compare only with WREI, in our study we observe higher incidence than in Hong Kong (around 125/100 000).<sup>13</sup> However, it is very difficult to compare these two values because the Hong Kong study covered a period of only 3 months.

The higher impact on males is similar to other studies where the percentage of eye injuries in males was between 87% and 95.1%.<sup>5 14-16</sup> A very similar RR was observed in Modena (Italy) (7:1 male/female ratio),<sup>5</sup> although it was lower in Taiwan (3.99).<sup>14</sup> It is important to highlight that these studies included not only the active population, so results are eye injuries but not only related to work. This higher impact on males might be due to the different occupations in each group too. In the last quarter of 2018 in Spain, there were 2.8 times more men than women working in industry and 10.6 times more in construction. These are the two workers' occupational sectors where the highest WREI incidence was observed in our study. However, there were 1.054 million more female workers in services.<sup>17</sup>

Age group of 35–44 was the most affected age group in our study. Our data match those found in an area in the southwest of China.<sup>16</sup> The highest percentage observed in other studies was in the 25–34 age group in Western Turkey<sup>15</sup> and the 16–24 age group in Modena (Italy).<sup>5</sup> However, we observed more incidence of WREI for 100 000 insured in the lowest age group (16–24) in our study, and this incidence decreases with age. We only analysed workers population, and we think this is why we found more eye injuries in the lowest age group. These workers have less experience and perform more manual jobs too. Our results suggest that work experience plays a protective role in Spanish workers as well as in other countries.<sup>5 15 18</sup>

As in other studies,<sup>5</sup> we observed the highest incidence and percentage of WREI in industry workers. Agriculture was the most affected group in other studies<sup>19 20</sup> but in all of them, services was the least affected group. This is due to the lower risk of trauma or other external agents that can affect services workers.

The multiple logistic regression analysis to study the interaction of the different variables, confirmed the results from the descriptive analysis. So, the highest incidence was observed in younger workers (aged between 16 and 24) and in males, confirming results from previous studies.<sup>21</sup>

When we analysed the evolution of WREI for 100 000 Ibermutua insured/accidents, we standardised data and eliminated WREI due to population variation. Therefore, we need to find reasons for the reduction in WREI in all study variables. This generalised decrease might be the result of unknown specific eye protection plans proposed by the companies and Ibermutua. Variation in occupational sector incidence over the study period could be another reason for this decrease. So, sectors with lower risk (agriculture and services) have increased his proportion (81% in 2018 vs 73% in 2008) and this makes that incidence of WREI also decrease in general.

There are no studies that compare WREI for accidents only (as opposed to total population). We considered it worth making this comparison to find out the mechanism and the importance that WREI have in total accidents in Spain. Using these data could make it easier to devise specific programmes aimed at reducing ocular accidents and the associated costs.

The high number of data of our database makes that a certain number of cases in the different variables was missing. Because of that, we don't have the same number of cases in all variables. These missed cases were not relevant in the sex and age group but were important in occupational sector groups (table 1). This becomes a limitation of our study and should be taken into account in future research in this area. Another limitation was the difficulty to compare with other studies where eye injuries are not only related to work, as far as they are carried out in the hospital's emergency departments.

## CONCLUSIONS

There is a higher risk of WREI for workers from industry and construction when compare to agriculture and services. Our results suggesting that experience is also an important factor for WREI, because younger workers shown more risk of suffering WREI. With these results, the main risk factors for suffering WREI was to be male, to be young and less experienced and work in manual task.

According to these results, specific protection programmes for higher protection in industry and services sectors should be proposed. We suggest the implantation of protective glasses and face shields in industry workers and visual ergonomic measures or instilling eye-drops in workers of the services sector.

**Contributors** CAP, CVC and MAST designed the study. CCR and ECB obtained the data. The obtained data was analysed by SMP and IT-V. All authors contributed to the writing of the manuscript.

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**Patient consent for publication** Not required.

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**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available on reasonable request. All data relevant to the study are included in the article, however, these data are available on a reasonable request. For this request, you can contact with the corresponding author on mail direction: martin.prieto.sergio@gmail.com.

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