BMJ Open

Eye Injury epidemiology of workers by age, sex and occupation over the last 10 years in Spain

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-035696
Article Type:	Original research
Date Submitted by the Author:	12-Nov-2019
Complete List of Authors:	Martin Prieto, Sergio; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Álvarez Peregrina, Cristina; Universidad Europea de Madrid Campus de Villaviciosa de Odón, School of Biomedical and Health Sciences Thuissard-Vasallo, Israel; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Catalina Romero, Carlos; Ibermutua (Mutua de accidentes de trabajo y enfermedades profesionales nº 274) Calvo Bonacho, Eva; Ibermutua (Mutua de accidentes de trabajo y enfermedades profesionales nº 274) Villa Collar, César; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Sánchez Tena, Miguel Ángel; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School
Keywords:	ACCIDENT & EMERGENCY MEDICINE, EPIDEMIOLOGY, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE, Medical ophthalmology < OPHTHALMOLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Eye Injury epidemiology of workers by age, sex and occupation over the last 10 years in Spain

Martín-Prieto, S. Msc[1], Alvarez-Peregrina, C. PhD[1], Thuissard-Vasallo, I. Msc[1], Catalina-Romero. C. PhD[2], Calvo-Bonacho, E. PhD[2], Villa-Collar, C. PhD[1], Sanchez-Tena, MA. PhD[1]

[1] School of Biomedical and Health Sciences, Universidad Europea de Madrid, Madrid 28670, Spain

[2] Ibermutua (Mutua colaboradora con la seguridad social nº 274), Madrid, Spain

martin.prieto.sergio@gmail.com

cristina.alvarez@universidadeuropea.es

israeljohn.thuissard@universidadeuropea.es

Carloscatalina@ibermutua.es

EvaCalvo@ibermutua.es

cesar.villa@universidadeuropea.es

miguelangel.sanchez@universidadeuropea.es

ABSTRACT:

OBJECTIVE: To describe the epidemiological characteristics of work-related eye injuries (WREI) in a mutual insurance company in Spain.

DESIGN AND SETTINGS: A descriptive, retrospective and longitudinal study based on data from workers insured by a labour insurance company in Spain from 1st January 2008 to 31st December 2018 was presented. The study considered the ratio of the number of WREI per 100000 population and the relative risk of suffering an ocular injury. The work-related eye injuries were characterised by sex, age and occupation.

PRIMARY AND SECONDARY OUTCOME MEASURES: Epidemiology of work-related eye injuries (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 such company, which has insured workers in all provinces of Spain over the study period.

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 the 35-44 age group (15,992; 31.8%), and in industry workers (18,899; 42.6%). The average incidence was 429.75/100,000 working population and 4,273.36/100,000 IBERMUTUA accidents. The incidence of WREI decreased over the study period in all variables. Males, 16-24 age group and industry occupation group have the highest relative risk (RR) and incidence for WREI.

CONCLUSIONS: Specific programs for ocular protection and changes in occupation over the 10-year study period were the most probable causes of the decrease in WREI incidence in our study.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- This study covers the largest area and the highest number of workers of those published in Europe to date.
- The long period of study indicates the results are not only due to specific changes in the insured company but rather to changes in Spanish workers.
- Because of characteristic statistical analysis in our study, it is very easy to check the relevance of sex, age and occupation with respect to WREI.

- Even though having the highest number of cases is an advantage, it makes analysis of the database very difficult, which explains why we missed some cases in the different variables.

FUNDING STATEMENT: The authors received no financial support for the research, authorship, and/or publication of this article.

COMPETING INTERESTS STATEMENT: The authors declare that there are no conflicts of interest regarding the publication of this paper.

WORD COUNT: 2534 words.

INTRODUCTION

An accident at work is defined in European Statistics on Accidents at Work (ESAW) methodology as a discrete occurrence during the course of work which leads to physical or mental harm (1). According to the Labour Force survey (LFS), 6.9 million accidents at work occurred in the European Union in 2007, affecting 3.2% of the population (2). In 2017, a total of 1.33 million of these accidents occurred in Spain, affecting 2.86% of the population (3). Within these statistics, WREI caused 16,245 workers to be absent from work in 2017 and the eye was the most affected structure in the head.

Prevalence of ocular injuries in developed countries ranges from 88 to 1,920 out of a 100,000 population (4,5), depending on the origin and the type of ocular injury. León Hernández et al. found that 20.2% of all ocular traumas in Spain in 1991 occurred in the workplace (6).

The universal plan of ocular health stablished by WHO for the period 2014-2019, has as a main goal decreasing vision impairment around the world (7). One of their secondary objectives is the generation of scientific data about the magnitude and causes of vision impairment in order to follow progress and could define priorities. WREI 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 though the knowledge about the epidemiology and mechanism of WREI.

The main objective of this study was the epidemiological characterization of WREI causing ocular injury in a mutual insurance company (IBERMUTUA) over a 10-year period in Spain.

METHODS

The research described herein adhered to the tenets of the Declaration of Helsinki and approved by ethic investigation committee of Universidad Europea de Madrid (CEI-UE). All medical records were anonymous; only statistical information was provided by IBERMUTUA for research purposes.

A descriptive, retrospective and longitudinal study was performed. We analysed WREI that affect any ocular structure during work time in a mutual insurance company. Study data were provided by IBERMUTUA. This company's 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 1st January 2008 to 31st December 2018.

The area of study covered all regions in Spain including Ceuta and Melilla, comprising an approximate area of 505,983 km² and a population of 46,650,300 in 2018 (8) (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.

INCLUSION CRITERIA

We studied WREI that affect any ocular structure during work time and *in itinere*. These injuries were evaluated and classified by medical specialists according to CIE-9-MC classification (correlations with ICD- where ocular injury is secondary to an accident involving other primary structures of the body.

We analysed sex (males and females), age and occupation. 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 (3). Occupation was classified according to the same Ministry's 2009 National Economic Activities Code (CNAE-2009 in Spanish), whereby occupation was divided into four groups: Agricultura, Industry, Construction and Services (3).

STATISTICAL ANALYSIS

Quantitative variables are given as a mean ± standard deviation (SD). For qualitative variables, absolute and relative frequencies are given in percentages. To standardize data, the relationship between number of WREI and insured/accident per 100,000 population in IBERMUTUA (ratio/100,000 population) was

calculated. A relative risk (RR) was computed to check the effects that exist between different groups of sex, age and occupation.

The chi-square test and the Fisher exact test was 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 Corp; Armonk, NY; USA), with $p<0.05$ considered significant for all analyses.

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 ±10.57 and the majority of all injuries occurred in 35-44 age group (15,992; 32.0%). Within the subject population, 44,445 were male (89.3%) and 5,349 female (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 4,273.36/100,000.

Workers insured by IBERMUTUA constituted an average of 5.81% (SD ±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).

INCIDENCE AND RELATIVE RISK (RR) PER 100,000 IBERMUTUA INSURED

The incidence of WREI over 10-year period was 680.12 for males and 103.63 for females. Therefore, males had 6.56 (95% CI 6.38-6.75) times more risk of suffering WREI than females (Table 2). If we analyse the evolution over the period, there was a decrease in incidence in both groups which was statistically significantly bigger in males than females (p=0.00027) (Figure 2a).

Highest incidence by age group corresponds to the 16-24 group (561.16). Incidence decreases with age. 487.27 in 25-34, 435.57 in 35-44, 369.42 in 45-54, and 316.69 in ≥ 55 group (Table 2). The ≥ 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 1.71-1.83), 1.54 (95% CI 1.51-1.57), 1.38 (95% CI 1.35-1.41), and 1.17 (95% CI 1.13-1.21)) (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 ≥ 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 7.55-7.92) times higher in Industry workers, 6.94 (95% CI 6.77-7.12) times higher in Construction workers, and 1.53 (95% CI 1.45-1.61) 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 RELATIVE RISK (RR) PER 100,000 IBERMUTUA ACCIDENTS

WREI incidence was 5125.26 for males and 1762.18 for females, with a RR 2.91 (95% CI 2.83-299) higher in males (table 2). Incidence throughout the period decreases over time and is statistically significant 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 1.46-1.56)), followed by 25-34 age group (4800.23 and RR 1.43 (95% CI 1.40-1.46)), 35-44 age group (4364.93 and RR 1.30 (95% CI 1.27-1.33)), 45-54 years group (3729.39 y RR 1.11 (95% CI 1.07-1.15)), and, used as reference and with the lowest incidence of all, the ≥ 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 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 3.74-3.92)), followed by Construction workers (6650; RR 2.54 (95% CI 2.48-5.60)), Agriculture workers (4495.75; RR 1.72 (95% CI 1.64-1.81)), 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).

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 number of workers in Spain (p=0.9987) indicates the importance of our data analysis.

The percentage of WREI in our study was lower than Gomez Villa et al. observed in two villages on the island of Mallorca (Spain) (0.84%). The difference was maybe due to the smaller area and population (only two villages and 50,851 workers) and the shorter study period (two years).

The total incidence of WREI falls between the values of other studies (4,5) and is very similar to that found by Karlsen et al. in Wisconsin (USA) in 1986 (423/100,000) (10). 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) (11). 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 in males is similar to other studies where the percentage of eye injuries in males was between 87 and 95.1% (5,12–14). A very similar RR was observed in Modena (Italy) (7:1 male/female ratio) (5), although it was lower in Taiwan (3.99) (12). This higher impact in males might be due to the different occupations in each group. 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 occupations where the highest WREI incidence was observed in our study. However, there were 1.054 million more female workers in Services (15).

35-44 was the most affected age group in our study. Our data match those found in an area in the southwest of China (14). The highest percentage observed in other studies was in 25-34 age group in

Western Turkey (13) and in 16-24 age group in Modena (Italy) (5). 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.

As in other studies (5), we observed the highest incidence and percentage of WREI in Industry workers. Agriculture was the most affected group in other studies (16,17) 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.

When we analysed the evolution of WREI for 100,000 IBERMUTUA insured/accidents, we standardized data and eliminated WREI due to population variation. Therefore, we need to find reasons for the reduction in WREI in all study variables. This generalized decrease is probably due to the implementation of specific eye protection plans by the companies and IBERMUTUA. Variation in occupation over the study period could be another reason, namely:

- Decrease in incidence is statistically significantly higher in males than females because in Spain a decrease in Industry and Construction workers was observed (18).
- The statistically significant decrease in 16-24 and 25-34 age groups could be due to the decreasing number of Spanish workers in these two occupation groups.

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

As we do not have the same number of cases in all variables (Table 1), this becomes a limitation of our study and should be taken into account in future research in this area.

CONCLUSIONS

Specific knowledge of the incidence and relative risk of work-related eye injuries could be essential for designing programs to prevent accidents in the workplace. This study contains the highest number of cases of any published in Europe to date, so the results are significant.

BIBLIOGRAPHY

1. Eurostat. Statistics Explained - Accidents at work statistics [Internet]. Eurostat Statistics Explained. 2015 [cited 2019 Oct 1]. p. 1–17. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php/Accidents_at_work_statistics
2. Eurostat. Health and safety at work in Europe (1999–2007) [Internet]. 2010. 96 p. Available from: http://ec.europa.eu/eurostat/documents/3217494/5718905/KS-31-09-290-EN.PDF/88eef9f7-c229-40de-b1cd-43126bc4a946
3. Ministerio de Empleo y Seguridad Social. Estadística de accidentes de trabajo 2017 [Internet]. 2018 [cited 2019 Oct 1]. p. 9–335. Available from: http://www.mitramiss.gob.es/estadisticas/eat/eat17/ATR_2017_Completa.pdf
4. Sahraravand A, Haavisto A-K, Holopainen JM, Leivo T. Ocular traumas in working age adults in Finland - Helsinki Ocular Trauma Study. Acta Ophthalmol. 2017 May;95(3):288–94.
5. Gobba F, Dall'Olio E, Modenese A, De Maria M, Campi L, Cavallini G. Work-Related Eye Injuries: A Relevant Health Problem. Main Epidemiological Data from a Highly-Industrialized Area of Northern Italy. Int J Environ Res Public Health. 2017 Jun 6;14(6):604.
6. León Hernández FA, Taboada Esteve JF, Guimerá V, Gálvez-Martínez J, Pérez Salvador JL, Gil A, et al. Primer año del estudio multicéntrico español sobre traumatismos oculares. Vol. 60, Archivos de la Sociedad Española de Oftalmología. 1991. p. 79–88.
7. OMS. Salud ocular universal : un plan de acción mundial para 2014-2019. In: Organizacion Mundial de la Salud. 2013. p. 1–25.
8. Instituto Nacional de estadística (INE). España en cifras 2019 [Internet]. Publicaciones oficiales BOE. 2019 [cited 2019 Jul 30]. p. 1–60. Available from: http://www.ine.es/prodyser/espa_cifras/2019/2/index.html
9. Ministerio de Sanidad Consumo y Bienestar Social. eCIE9MC [Internet]. Edición electrónica de la CIE-9-MC. 9ª Edición. 2014 [cited 2019 Jul 30]. Available from: https://eciemaps.mscbs.gob.es/ecieMaps/browser/index_9_mc.html#search=&flags=111100&flagsLT=11111111&searchId=1564475344573&indiceAlfabetico=&listaTabular=id-11528-class-360-379&expand=0&clasification=cie9mc&version=2014
10. Karlson TA, Klein BEK. The Incidence of Acute Hospital-Treated Eye Injuries. Arch Ophthalmol. 1986 Oct 1;104(10):1473–6.
11. Yu TSI, Liu H, Hui K. A case-control study of eye injuries in the workplace in Hong Kong. Ophthalmology. 2004 Jan 1;111(1):70–4.
12. Ho C-K, Yen Y-L, Chang C-H, Chiang H-C, Shen Y-Y, Chang P-Y. Epidemiologic Study on Work-related Eye Injuries in Kaohsiung, Taiwan. Kaohsiung J Med Sci [Internet]. 2007 Sep;23(9):463–9. Available from: http://doi.wiley.com/10.1016/S1607-551X(08)70054-8
13. Serinken M, Turkcuer I, Cetin EN, Yilmaz A, Elicabuk H, Karcioglu O. Causes and characteristics of work-related eye injuries in western Turkey. Indian J Ophthalmol. 2013 Sep;61(9):497–501.
14. Cai M, Zhang J. Epidemiological Characteristics of Work-Related Ocular Trauma in Southwest Region of China. Int J Environ Res Public Health. 2015 Aug 19;12(8):9864–75.
15. Instituto Nacional de estadística (INE). Encuesta de población Activa (EPA) 2018T4. [Internet]. Resultados Nacionales. Ocupados por grupo de edad, sexo y sector económico. 2018 [cited 2019 Mar 8]. Available from: http://www.ine.es/jaxiT3/Tabla.htm?t=3959&L=0
16. Jovanovic N, Peek-Asa C, Swanton A, Young T, Alajbegovic-Halimic J, Cavaljuga S, et al. Prevalence and risk factors associated with work-related eye injuries in Bosnia and Herzegovina. Int J Occup Environ Health. 2016 Oct 4;22(4):325–32.
17. Cruciani F, Lucchetta F, Regine F, Salandri AG, Abdolrahimzadeh B, Balacco Gabrieli C. Work-related accidents of ophthalmologic interest in Italy during 1986-1991. Ophthalmologica. 1997;211(4):251–5.
18. Instituto Nacional de estadística (INE). Encuesta de población activa (EPA). Activos por nacionalidad, sexo y sector económico 2008-2018 [Internet]. Encuesta de población Activa (EPA). Resultados nacionales. 2019 [cited 2019 Jul 30]. Available from: http://www.ine.es/jaxiT3/Tabla.htm?t=3959&L=

CONTRIBUTORSHIP STATEMENT:

Alvarez-Peregrina, Villa-Collar and Sanchez-Tena designed the study.

Catalina-Romero and Calvo-Bonacho obtained the data.

The obtained data was analysed by Martín-Prieto and Thuissard-Vasallo.

All authors contributed to the writing of the manuscript.

COMPETING INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this paper.

FUNDING

The authors received no financial support for the research, authorship, and/or publication of this article.

DATA SHARING STATEMENT

All data relevant to the study are included in the article or uploaded as supplementary information. Data are also available upon reasonable request.

Table 1: Total cases (N) of IBERMUTUA insured, IBERMUTUA accidents and total WREI (Work-related eye injuries) according to sex, age and workers occupation. Losses: total number of losses out of total number of cases (50265) of WREI in all different groups.

	TOTAL		LOSSES	
	N	%	N	%
Ibermutua insured	11,696,259			
Ibermutua accidents	1,17,9067			
Spanish workers	201,167,800			
WREI	50,265			
Sex WREI				
Male	44,445	89.3		
Female	5,349	10.7		
Total	49,794	100	471	0.9
Age group WREI				
16-24	4,388	8.8		
25-34	14,981	29.9		
35-44	15,992	32.0		
45-54	10,278	20.5		
>55	4,390	8.8		
Total	50,029	100	236	0.5
Occupation WREI				
Agriculture	1,624	3.7		
Industry	18,899	42.6		
Construction	10,455	23.6		
Services	13,394	30.2		
Total	44,369	100	5,893	11.7

Table 2: Incidence of WREI over 100,000 IBERMUTUA insured/accidents and relative risk (RR) of WREI over the period study according to sex, age and workers occupation.

	WREI incidence out of 100,000 Ibermutua insured	WREI incidence out of 100,000 Ibermutua accidents	RR WREI according tolbermutua insured		RR WREI according to Ibermutua accidents	
			RR	95% CI	RR	95% CI
Sex						
Total	425,73	4253,29				
Male	680,13	5125,27	6,56	6,38-6,75	2,91	2,83-2,99
Female	103,63	1762,19	REF		REF	
Age						
Total	427,74	4273,36				
16-24 years	561,16	5083,65	1,77	1,71-1,83	1,51	1,46-1,56
25-34 years	487,27	4800,23	1,54	1,51-1,57	1,43	1,40-1,46
35-44 years	435,58	4364,94	1,38	1,35-1,41	1,30	1,27-1,33
45-54 years	369,43	3729,40	1,17	1,13-1,21	1,11	1,07-1,15
>55 Years	316,69	3368,01	REF		REF	
Occupation						
Total	479,65	4719,61				
Agriculture	305,14	4495,75	1,53	1,45-1,61	1,72	1,64-1,81
Industry	1538,18	8050,69	7,73	7,55-7,92	3,83	3,74-3,92
Construction	1381,53	6650,00	6,94	6,77-7,12	2,54	2,48-2,60
Services	198,92	2615,65	REF		REF	

Figure Legends:

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).

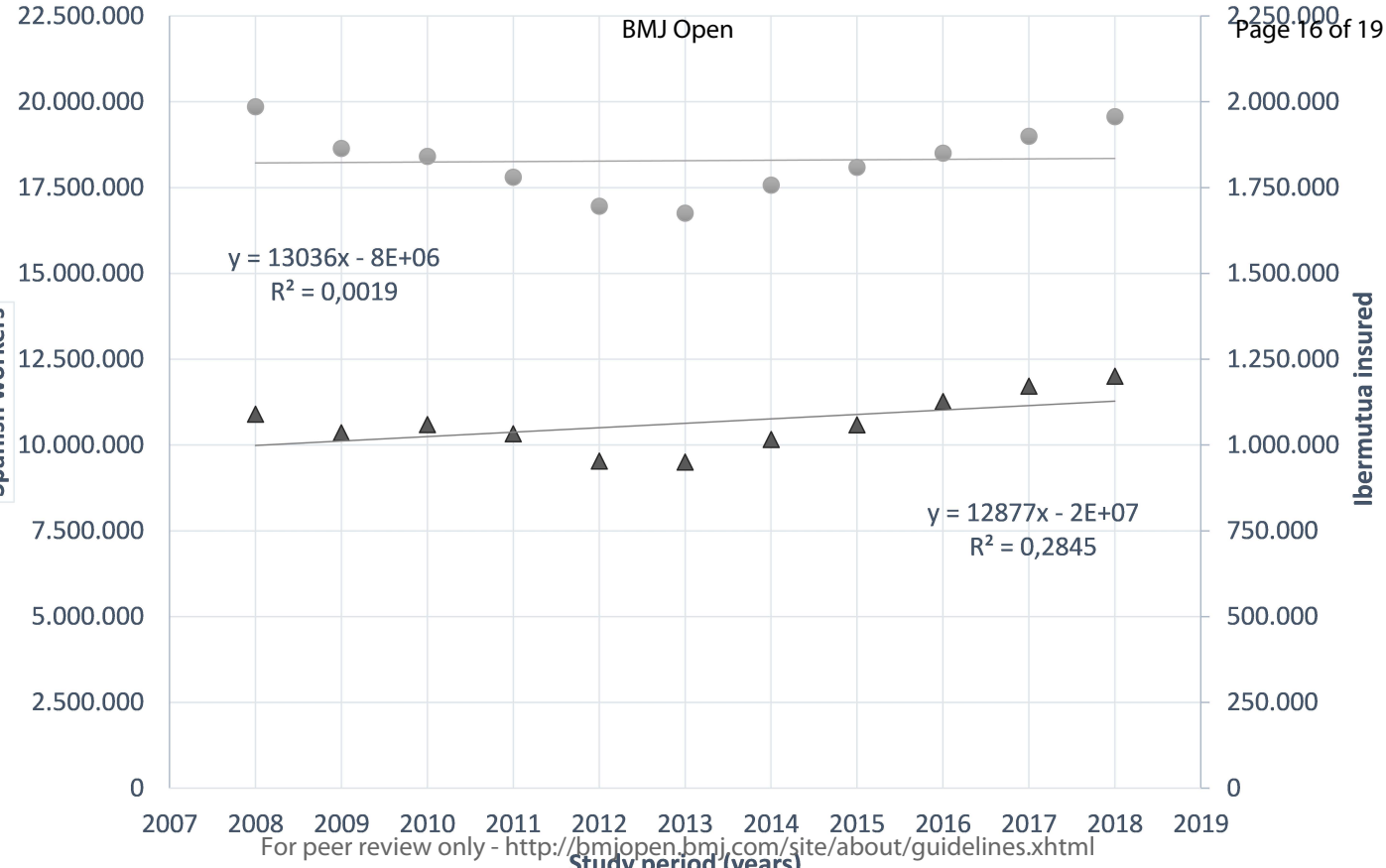
Figure 2: Evolution of WREI incidence per 100000 IBERMUTUA insured over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed.

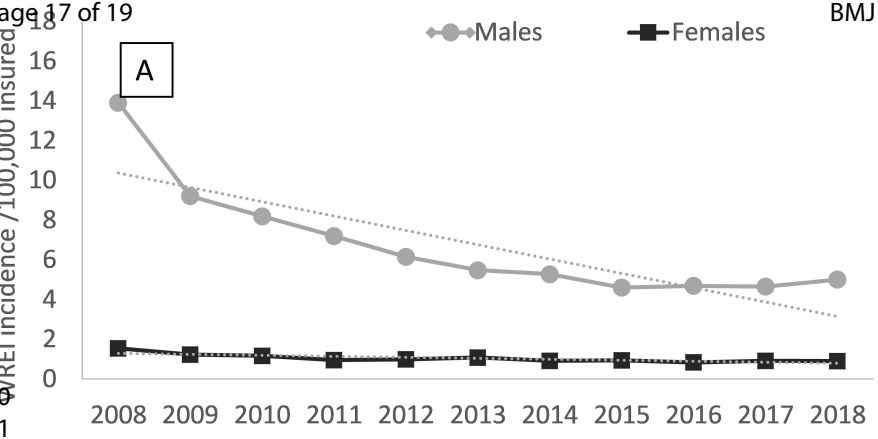
Figure 3: Evolution of WREI incidence per 100000 IBERMUTUA accidents over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed.

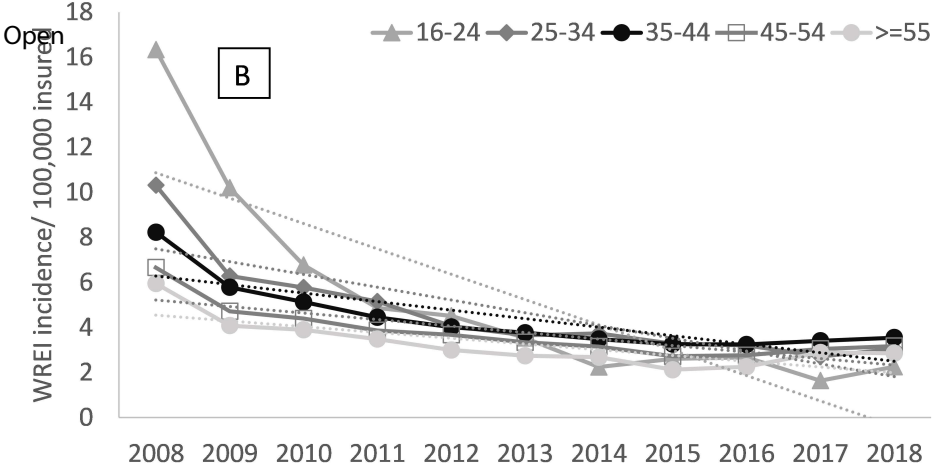
STROBE CHEKLIST

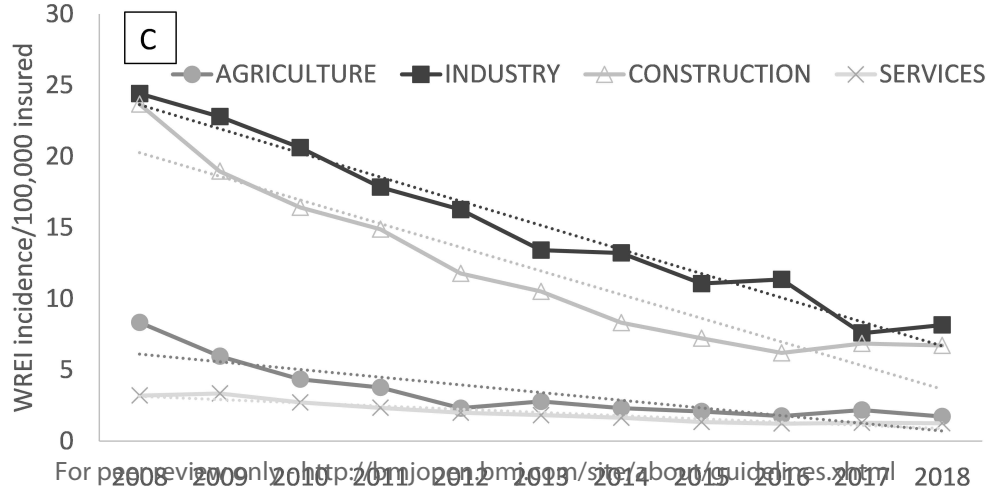
STROBE CHECLIST ITEM NUMBER	**NUMBER OF PAGE ON MANUSCRIPT**
Title and Abstract 1	**Page 1, 2**
Background/rationale 2	**Page 3**
Objectives 3	**Page 3**
Study design 4	**Page 4**
Setting 5	**Page 4**
Participants 6	**Page 4**
Variables 7	**Page 4**
Data sources/measurements 8	**Page 4**
Bias 9	**n/c**
Study size 10	**Page 4**
Quantitative variables 11	**Page 4**
Statistical methods 12	**Page 5**
Participants 13	**Page 5**
Descriptive data 14	**Page 5**
Outcome data 15	**n/c**
Main results 16	**Page 5, 6 y 7**
Other analyses 17	**Page 5, 6 y 7**
Key results 18	**Page 7, 8**

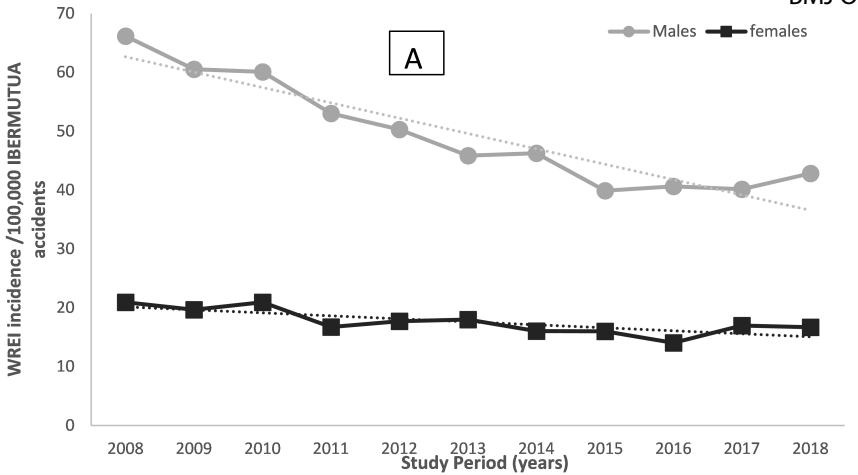
Limitations 19	**Page 8**
Interpretation 20	**Page 7 y 8**
Generalisability 21	**Page 8**
Funding 22	**Page 10**

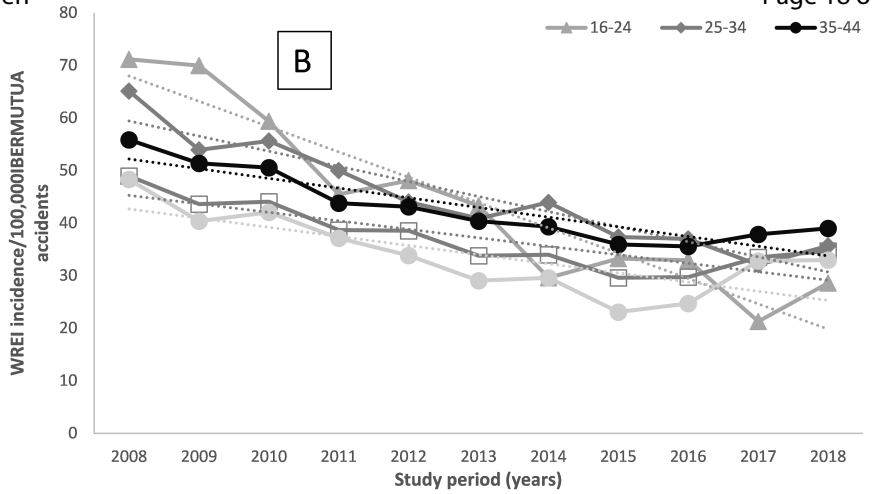


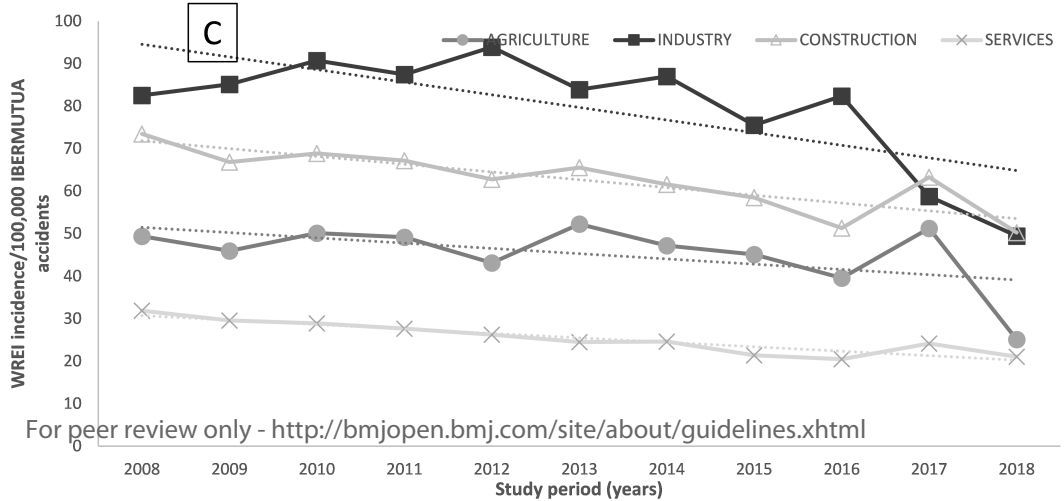












STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Description of the epidemiological characteristics of work-related eye injuries in Spain. A retrospective study.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-035696.R1
Article Type:	Original research
Date Submitted by the Author:	16-Mar-2020
Complete List of Authors:	Martin Prieto, Sergio; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Álvarez Peregrina, Cristina; Universidad Europea de Madrid Campus de Villaviciosa de Odón, School of Biomedical and Health Sciences Thuissard-Vasallo, Israel; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Catalina Romero, Carlos; Ibermutua (Mutua de accidentes de trabajo y enfermedades profesionales nº 274) Calvo Bonacho, Eva; Ibermutua (Mutua de accidentes de trabajo y enfermedades profesionales nº 274) Villa Collar, César; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Sánchez Tena, Miguel Ángel; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Ophthalmology, Epidemiology
Keywords:	ACCIDENT & EMERGENCY MEDICINE, EPIDEMIOLOGY, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE, Medical ophthalmology < OPHTHALMOLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Description of the epidemiological characteristics of work-related eye injuries in Spain. A retrospective study.

Martín-Prieto, S. Msc[1], Alvarez-Peregrina, C. PhD[1], Thuissard-Vasallo, I. Msc[1], Catalina-Romero. C. PhD[2], Calvo-Bonacho, E. PhD[2], Villa-Collar, C. PhD[1], Sanchez-Tena, MA. PhD[1]

[1] School of Biomedical and Health Sciences, Universidad Europea de Madrid, Madrid 28670, Spain

[2] Ibermutua (Mutua colaboradora con la seguridad social nº 274), Madrid, Spain

martin.prieto.sergio@gmail.com

cristina.alvarez@universidadeuropea.es

israeljohn.thuissard@universidadeuropea.es

Carloscatalina@Ibermutua.es

EvaCalvo@Ibermutua.es

villacollarc@gmail.com

miguelangel.sanchez@universidadeuropea.es

ABSTRACT:

OBJECTIVE: To describe the epidemiological characteristics and trends of work-related eye injuries (WREI) in Spain over a 10-years 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 100000 population and the relative risk of suffering an ocular injury. WREI were characterized 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 4,273.36 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 6.38-6.75) times more risk of suffering WREI than females. 16-24 age group have 1.77 (95% CI 1.71-1.83) times more risk than in the group of workers older than 55. Finally, industry workers have 7.73 (95% CI 7.55-7.92) times more risk than services workers.

CONCLUSIONS: Specific knowledge and description of the incidence and relative risk of work-related eye injuries is the first step for designing programs to prevent accidents in the workplace.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- Data is 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 years period, including an economic crisis during the period studied.
- Data is collected from only one mutual insurance company

- Economic activities have been classified according to CNAE-2009 and not divided into specific groups

FUNDING STATEMENT: The authors received no financial support for the research, authorship, and/or publication of this article.

COMPETING INTERESTS STATEMENT: The authors declare that there are no conflicts of interest regarding the publication of this paper.

WORD COUNT: 2556 words.

INTRODUCTION

An accident at work is defined in European Statistics on Accidents at Work (ESAW) methodology as a discrete occurrence during the course of work which leads to physical or mental harm (1). According to the Labour Force Survey (LFS), 6.9 million accidents at work occurred in the European Union in 2007, affecting 3.2% of the population (2). In 2017, a total of 1.33 million of these accidents occurred in Spain, affecting 2.86% of the population (3). Within these statistics, WREI caused 16,245 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 1,920 out of a 100,000 population (4,5), depending on the origin and the type of ocular injury. León Hernández et al. found that 20.2% of all ocular traumas in Spain in 1991 occurred in the workplace (6). The percentage of ocular injuries related to work changes along with the world from 0.84 to 3.4% (7-9). 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 (7). 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. WREI 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 characterization of WREI causing ocular injury in Spain by sex, age and occupational sectors over a 10-years period.

METHODS

A descriptive, retrospective and longitudinal study were performed. We analyzed WREI that affects 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 authorized 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, analyzing the work-related injury and its consequences for insured workers. The study period was from 1st January 2008 to 31st December 2018.

The area of study covered all regions in Spain including Ceuta and Melilla with a population of 46,650,300 in 2018 (7) (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 (8).

The research described herein adhered to the tenets of the Declaration of Helsinki and approved by the ethic investigation committee of Universidad Europea de Madrid (CEI-UE). All medical records were anonymous; only statistical information was provided by Ibermutua for research purposes.

INCLUSION CRITERIA

We studied WREI that affects any ocular structure during work time and in itinere. These injuries were evaluated and classified by medical specialists according to CIE-9-MC classification, correlations with 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 (3). The occupational sector was classified according to the same Ministry's 2009 National Economic Activities Code (CNAE-2009 in Spanish), whereby occupational sector was divided into four groups: Agricultura, Industry, Construction, and Services (3).

STATISTICAL ANALYSIS

Quantitative variables are given as a mean ± standard deviation (SD). For qualitative variables, absolute and relative frequencies are given in percentages. To standardize data, the relationship between the number of WREI per 100,000 population in Ibermutua (ratio/100,000 population) was calculated. Ibermutua data was 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.

The chi-square test and the Fisher exact test was 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 Corp; Armonk, NY; USA), 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 ±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 5,349 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 4,273.36/100,000.

Workers insured by Ibermutua constituted an average of 5.81% (SD ±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 and industry. The decrease in Spanish construction workers was higher than Ibermutua construction insured over the study period, however, the trend is very similar. This trend was very different in Agriculture where Spanish workers decrease against Ibermutua insured who increased its number.

INCIDENCE AND RELATIVE RISK (RR) PER 100,000 IBERMUTUA INSURED

The incidence of WREI over 10-year period was 680.12 for males and 103.63 for females. Therefore, males had 6.56 (95% CI 6.38-6.75) times more risk of suffering WREI than females (Table 2). If we analyse the evolution over the period, there was a decrease in incidence in both groups which was statistically significantly 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 ≥ 55 group (Table 2). The ≥ 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 1.71-1.83), 1.54 (95% CI 1.51-1.57), 1.38 (95% CI 1.35-1.41), and 1.17 (95% CI 1.13-1.21)) (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 ≥ 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 7.55-7.92) times higher in Industry workers, 6.94 (95% CI 6.77-7.12) times higher in Construction workers, and 1.53 (95% CI 1.45-1.61) 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 RELATIVE RISK (RR) PER 100,000 IBERMUTUA ACCIDENTS

WREI incidence was 5125.26 for males and 1762.18 for females, with a RR 2.91 (95% CI 2.83-299) 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 1.46-1.56)), followed by 25-34 age group (4800.23 and RR 1.43 (95% CI 1.40-1.46)), 35-44 age group (4364.93 and RR 1.30 (95% CI 1.27-1.33)), 45-54 years group (3729.39 y RR 1.11 (95% CI 1.07-1.15)), and, used as a reference and with the lowest incidence of all, the ≥ 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 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 3.74-3.92)), followed by Construction workers (6650; RR 2.54 (95% CI 2.48-5.60)), Agriculture workers (4495.75; RR 1.72 (95% CI 1.64-1.81)), 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).

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 percentage of WREI in our study was lower than Gomez Villa et al. observed in two villages on the island of Mallorca (Spain) (0.84%) (9), Torino (Italy) (1.3%) (10) and much lower than another with a similar number of study cases in the USA (3.4%) (11). The difference was maybe due to the smaller area and population (only two villages and 50,851 workers) and the shorter study period (two years) 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 (4,5) and is very similar to that found by Karlsen et al. in Wisconsin (USA) in 1986 (423/100,000) (12). 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) (13). 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% (5,14–16). A very similar RR was observed in Modena (Italy) (7:1 male/female ratio) (5), although it was lower in Taiwan (3.99) (14). 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 (17).

35-44 was the most affected age group in our study. Our data match those found in an area in the southwest of China (16). The highest percentage observed in other studies was in the 25-34 age group in Western Turkey (15) and the 16-24 age group in Modena (Italy) (5). 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.

As in other studies (5), we observed the highest incidence and percentage of WREI in Industry workers. Agriculture was the most affected group in other studies (18,19) 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.

When we analysed the evolution of WREI for 100,000 Ibermutua insured/accidents, we standardized data and eliminated WREI due to population variation. Therefore, we need to find reasons for the reduction in WREI in all study variables. This generalized 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 in order to find out the mechanism and the importance that WREI have in total accidents in Spain. Using this data could make it easier to devise specific programs aimed at reducing ocular accidents and the associated costs.

Because of the higher number of data, a certain number of cases in the different variables was missing. 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

Specific and descriptive knowledge of the incidence and relative risk of work-related eye injuries is the first step for designing programs to prevent accidents in the workplace.

There is a higher risk of WREI for workers from Industry and Construction when compare to Agriculture and Services. Experience is also an important factor for WREI, having younger workers more risk of suffering WREI.

BIBLIOGRAPHY

1. Eurostat. Statistics Explained - Accidents at work statistics [Internet]. Eurostat Statistics Explained. 2015 [cited 2019 Oct 1]. p. 1–7. Available from: http://ec.europa.eu/eurostat/statistics-explained/
2. Eurostat. Health and safety at work in Europe (1999–2007) - A statistical portrait [Internet]. Publications Office of the European Union. 2010. 96 p. Available from: http://ec.europa.eu/eurostat/documents/3217494/5718905/KS-31-09-290-EN.PDF/88eef9f7-c229-40de-b1cd-43126bc4a946
3. 1Dirección General de Estadística y Análisis Sociolaboral D. Resumen. Estadística de Accidentes de Trabajo 2017 [Internet]. Ministerio de empleo y seguridad Social. 2017 [cited 2019 Oct 1]. p. 9. Available from: http://www.mitramiss.gob.es/estadisticas/eat/eat17/ATR_2017_Completa.pdf
4. Sahraravand A, Haavisto AK, Holopainen JM, Leivo T. Ocular traumas in working age adults in Finland – Helsinki Ocular Trauma Study. Acta Ophthalmol. 2017 May;95(3):288–94.
5. Gobba F, Dall'Olio E, Modenese A, De Maria M, Campi L, Cavallini GM. Work-related eye injuries: A relevant health problem. main epidemiological data from a highly-industrialized area of northern Italy. Int J Environ Res Public Health. 2017 Jun 6;14(6):604.
6. León Hernández FA, Taboada Esteve JF, Guimerá V, Gálvez-Martínez J, Pérez Salvador JL, Gil A, et al. Primer año del estudio multicéntrico español sobre traumatismos oculares. [Internet]. Vol. 60, Archivos de la Sociedad Epañola de Oftalmología. 1991 [cited 2019 Oct 2]. p. 79–88. Available from: https://dialnet.unirioja.es/servlet/articulo?codigo=6768620
7. Instituto Nacional de estadística (INE). España en cifras 2019 [Internet]. Publicaciones oficiales BOE. 2019 [cited 2019 Jul 30]. p. 1–60. Available from: http://www.ine.es/prodyser/espa_cifras/2019/2/index.html
8. Instituto Nacional de estadística (INE). Sección prensa / Encuesta de Población Activa (EPA). Serie histórica (Datos en miles de personas) [Internet]. 2014 [cited 2019 Dec 18]. Available from: https://www.ine.es/prensa/epa_tabla.htm
9. Gómez Villa P, Ladaria Lliteras A. Patología oftálmica en el medio laboral: ergooftalmología [Internet]. 2007 [cited 2019 Dec 28]. p. 1–85. Available from: http://diposit.ub.edu/dspace/bitstream/2445/7101/1/PATOLOGIA OFTALMICA.pdf
10. Fea A, Bosone A, Rolle T, Grignolo FM. Eye injuries in an Italian urban population: Report of 10620 cases admitted to an eye emergency department in Torino. Graefe's Arch Clin Exp Ophthalmol [Internet]. 2008 Feb;246(2):175–9. Available from: https://search.ebscohost.com/login.aspx?direct=true&db=mdc&AN=18183412&lang=es&site=ehost-live&scope=site
11. Stagg BC, Shah MM, Talwar N, Padovani-Claudio DA, Woodward MA, Stein JD. Factors Affecting Visits to the Emergency Department for Urgent and Nonurgent Ocular Conditions. Ophthalmology [Internet]. 2017/01/31. 2017 May;124(5):720–9. Available from: https://pubmed.ncbi.nlm.nih.gov/28159379
12. Klein BEK. The Incidence of Acute Hospital-Treated Eye Injuries. Arch Ophthalmol. 1986 Oct 1;104(10):1473–6.
13. Yu TSI, Liu H, Hui K. A Case-Control Study of Eye Injuries in the Workplace in Hong Kong. Ophthalmology. 2004 Jan 1;111(1):70–4.
14. Ho CK, Yen YL, Chang CH, Chiang HC, Shen YY, Chang PY. Epidemiologic study on work-related eye injuries in Kaohsiung, Taiwan. Kaohsiung J Med Sci [Internet]. 2007 Sep;23(9):463–9. Available from: http://doi.wiley.com/10.1016/S1607-551X(08)70054-8
15. Serinken M, Turkcuer I, Cetin EN, Yilmaz A, Elicabuk H, Karcioglu O. Causes and characteristics of work-related eye injuries in western Turkey. Indian J Ophthalmol. 2013 Sep;61(9):497–501.
16. Cai M, Zhang J. Epidemiological characteristics of work-related ocular trauma in southwest region of China. Int J Environ Res Public Health. 2015 Aug 19;12(8):9864–75.
17. Instituto Nacional de estadística (INE). Encuesta de población Activa (EPA) 2018T4. [Internet]. Resultados Nacionales. Ocupados por grupo de edad, sexo y sector económico. 2018 [cited 2019 Mar 8]. Available from: http://www.ine.es/jaxiT3/Tabla.htm?t=3959&L=0
18. Jovanovic N, Peek-Asa C, Swanton A, Young T, Alajbegovic-Halimic J, Cavaljuga S, et al. Prevalence and risk factors associated with work-related eye injuries in Bosnia and Herzegovina. Int J Occup Environ Health. 2016 Oct 4;22(4):325–32.
19. Cruciani F, Lucchetta F, Regine F, Salandri Y, Abdolrahimzadeh B, Gabrieli B. Work–Related

Accidents of Ophthalmologic Interest in Italy During 1986–1991. Ophthalmologica. 1997;211(4):251–5.

CONTRIBUTORSHIP STATEMENT:

Alvarez-Peregrina, Villa-Collar and Sanchez-Tena designed the study.

Catalina-Romero and Calvo-Bonacho obtained the data.

The obtained data was analysed by Martín-Prieto and Thuissard-Vasallo.

All authors contributed to the writing of the manuscript.

COMPETING INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this paper.

FUNDING

The authors received no financial support for the research, authorship, and/or publication of this article.

DATA SHARING STATEMENT

All data relevant to the study are included in the article or uploaded as supplementary information. Data are also available upon reasonable request.

Table 1: Total cases (N) of Ibermutua-insured, Ibermutua accidents and total WREI (Work-related eye injuries) according to sex, age and workers occupation. Losses: total number of losses out of total number of cases (50265) of WREI in all different groups.

	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	5,349	10.7		
Total	49,794	100	471	0.9
Age group WREI				
16-24	4,388	8.8		
25-34	14,981	29.9		
35-44	15,992	32.0		
45-54	10,278	20.5		
>55	4,390	8.8		
Total	50,029	100	236	0.5
Occupation WREI				
Agriculture	1,624	3.7		
Industry	18,899	42.6		
Construction	10,455	23.6		
Services	13,394	30.2		
Total	44,369	100	5,893	11.7

Table 2: Incidence of WREI over 100,000 insured and 1000,000 accidents and relative risk (RR) of WREI over a 10-year period according to sex, age and sector.

	WREI incidence per 100,000 insured	WREI incidence per 100,000 accidents	RR WREI according to insured		RR WREI according to accidents	
			RR	95% CI	RR	95% CI
Sex						
Total	425,73	4253,29				
Male	680,13	5125,27	6,56	6,38-6,75	2,91	2,83-2,99
Female	103,63	1762,19	REF		REF	
Age						
Total	427,74	4273,36				
16-24 years	561,16	5083,65	1,77	1,71-1,83	1,51	1,46-1,56
25-34 years	487,27	4800,23	1,54	1,51-1,57	1,43	1,40-1,46
35-44 years	435,58	4364,94	1,38	1,35-1,41	1,30	1,27-1,33
45-54 years	369,43	3729,40	1,17	1,13-1,21	1,11	1,07-1,15
>55 Years	316,69	3368,01	REF		REF	
Sector						
Total	479,65	4719,61				
Agriculture	305,14	4495,75	1,53	1,45-1,61	1,72	1,64-1,81
Industry	1538,18	8050,69	7,73	7,55-7,92	3,83	3,74-3,92
Construction	1381,53	6650,00	6,94	6,77-7,12	2,54	2,48-2,60
Services	198,92	2615,65	REF		REF	

Figure Legends:

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).

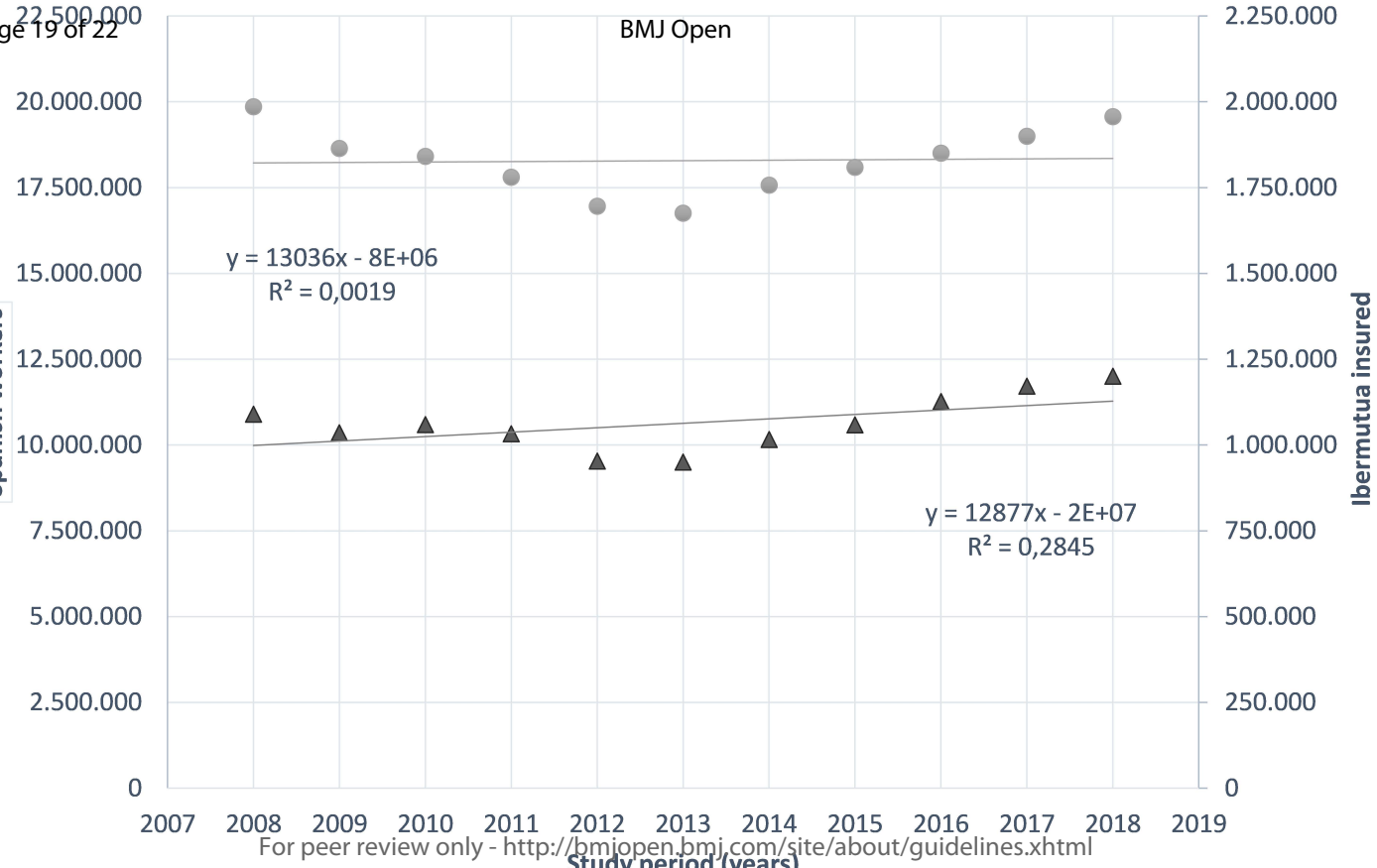
Figure 2: Evolution of WREI incidence per 100000 Ibermutua insured over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed.

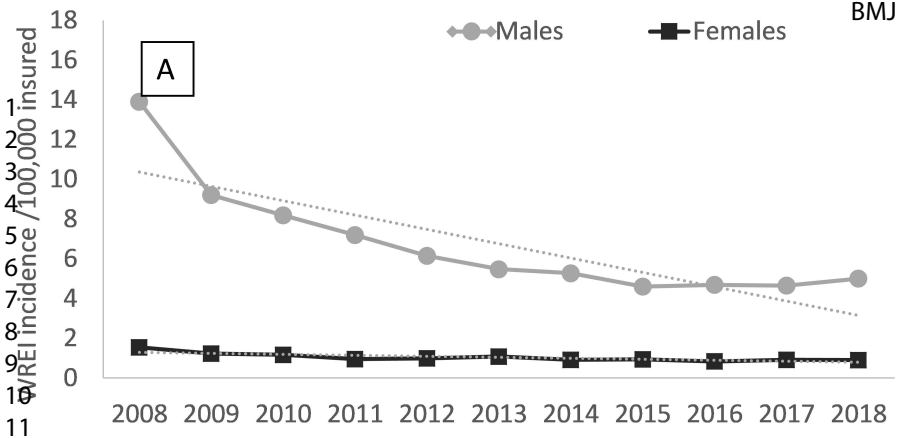
Figure 3: Evolution of WREI incidence per 100000 Ibermutua accidents over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed.

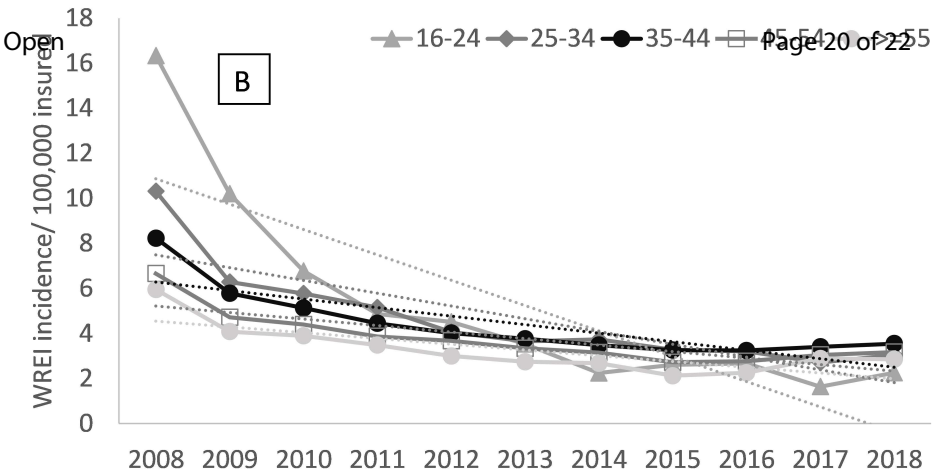
STROBE CHEKLIST

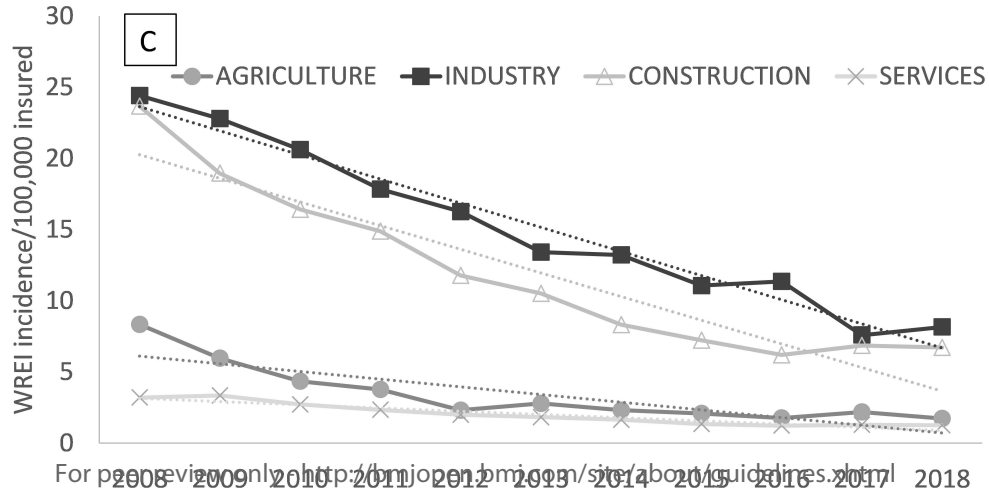
STROBE CHECLIST ITEM NUMBER	**NUMBER OF PAGE ON MANUSCRIPT**
Title and Abstract 1	**Page 1, 2**
Background/rationale 2	**Page 3**
Objectives 3	**Page 3**
Study design 4	**Page 4**
Setting 5	**Page 4**
Participants 6	**Page 4, 5**
Variables 7	**Page 4, 5**
Data sources/measurements 8	**Page 4, 5**
Bias 9	**n/c**
Study size 10	**Page 4**
Quantitative variables 11	**Page 4**
Statistical methods 12	**Page 5**
Participants 13	**Page 4, 5**

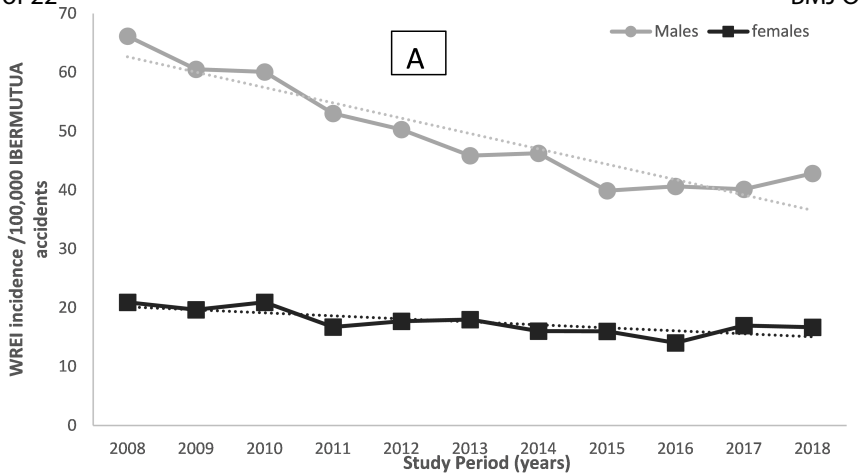
Descriptive data 14	**Page 5, 6**
Outcome data 15	**n/c**
Main results 16	**Page 5, 6 y 7**
Other analyses 17	**Page 5, 6 y 7**
Key results 18	**Page 8, 9**
Limitations 19	**Page 9**
Interpretation 20	**Page 9, 10**
Generalisability 21	**Page 8, 9**
Funding 22	**Page 13**

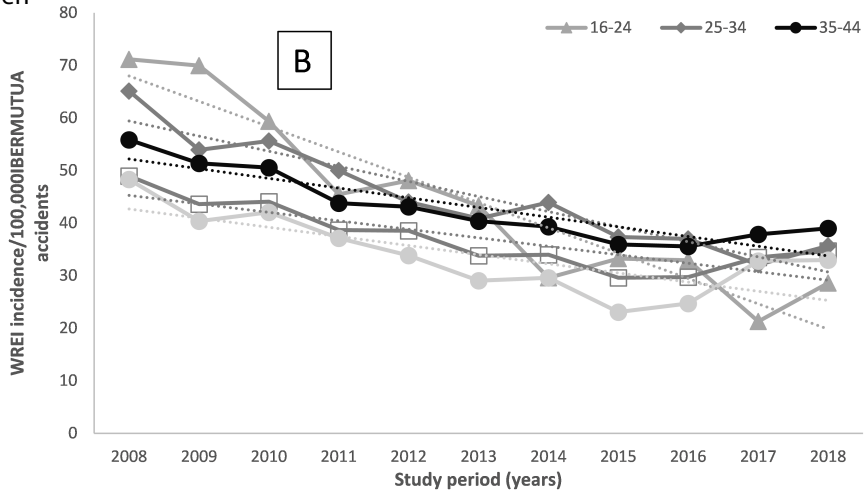


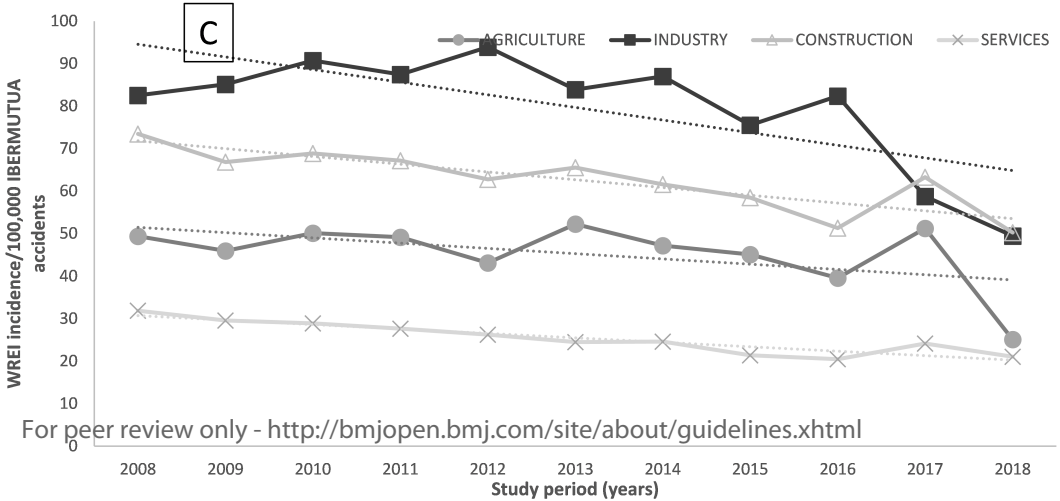












STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Description of the epidemiological characteristics of work-related eye injuries in Spain. A retrospective study.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-035696.R2
Article Type:	Original research
Date Submitted by the Author:	11-Jul-2020
Complete List of Authors:	Martin Prieto, Sergio; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Álvarez Peregrina, Cristina; Universidad Europea de Madrid Campus de Villaviciosa de Odón, School of Biomedical and Health Sciences Thuissard-Vasallo, Israel; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Catalina Romero, Carlos; Ibermutua (Mutua de accidentes de trabajo y enfermedades profesionales nº 274) Calvo Bonacho, Eva; Ibermutua (Mutua de accidentes de trabajo y enfermedades profesionales nº 274) Villa Collar, César; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School Sánchez Tena, Miguel Ángel; Universidad Europea de Madrid Campus de Villaviciosa de Odón, Biomedical and Health Science School
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Ophthalmology, Epidemiology
Keywords:	ACCIDENT & EMERGENCY MEDICINE, EPIDEMIOLOGY, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE, Medical ophthalmology < OPHTHALMOLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Description of the epidemiological characteristics of work-related eye injuries in Spain. A retrospective study.

Martín-Prieto, S. Msc[1], Alvarez-Peregrina, C. PhD[1], Thuissard-Vasallo, I. Msc[1], Catalina-Romero. C. PhD[2], Calvo-Bonacho, E. PhD[2], Villa-Collar, C. PhD[1], Sanchez-Tena, MA. PhD[1]

[1] School of Biomedical and Health Sciences, Universidad Europea de Madrid, Madrid 28670, Spain

[2] Ibermutua (Mutua colaboradora con la seguridad social nº 274), Madrid, Spain

Corresponding author: martin.prieto.sergio@gmail.com

cristina.alvarez@universidadeuropea.es

israeljohn.thuissard@universidadeuropea.es

carloscatalina@ibermutua.es

EvaCalvo@ibermutua.es

villacollarc@gmail.com

miguelangel.sanchez@universidadeuropea.es

ABSTRACT:

OBJECTIVE: To describe the epidemiological characteristics and trends of work-related eye injuries (WREI) in Spain over a 10-years 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 100000 population and the relative risk of suffering an ocular injury. WREI were characterized 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 4,273.36 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 6.38-6.75) times more risk of suffering WREI than females. 16-24 age group have 1.77 (95% CI 1.71-1.83) times more risk than in the group of workers older than 55. Finally, industry workers have 7.73 (95% CI 7.55-7.92) 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.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- Data is 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 years period, including an economic crisis during the period studied.
- Data is collected from only one mutual insurance company

- Economic activities have been classified according to CNAE-2009 and not divided into specific groups

FUNDING STATEMENT: The authors received no financial support for the research, authorship, and/or publication of this article.

COMPETING INTERESTS STATEMENT: The authors declare that there are no conflicts of interest regarding the publication of this paper.

WORD COUNT: 2938 words.

INTRODUCTION

An accident at work is defined in European Statistics on Accidents at Work (ESAW) methodology as a discrete occurrence during the course of work which leads to physical or mental harm [1]. According to the Labour Force Survey (LFS), 6.9 million accidents at work occurred in the European Union in 2007, affecting 3.2% of the population [2]. In 2017, a total of 1.33 million of these accidents occurred in Spain, affecting 2.86% of the population [3]. Within these statistics, WREI caused 16,245 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 1,920 out of a 100,000 population [4,5], depending on the origin and the type of ocular injury. León Hernández et al. found that 20.2% of all ocular traumas in Spain in 1991 occurred in the workplace [6]. The percentage of ocular injuries related to work changes along with the world from 0.84 to 3.4% [7-9]. 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 [7]. 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. WREI 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 characterization of WREI causing ocular injury in Spain by sex, age and occupational sectors over a 10-years period.

METHODS

A descriptive, retrospective and longitudinal study were performed. We analyzed WREI that affects 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 authorized 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, analyzing the work-related injury and its consequences for insured workers. The study period was from 1st January 2008 to 31st December 2018.

The area of study covered all regions in Spain including Ceuta and Melilla with a population of 46,650,300 in 2018 [7] (latest census). In these years, we analyzed 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 [8].

The research described herein adhered to the tenets of the Declaration of Helsinki and approved by the ethic investigation committee of Universidad Europea de Madrid (CEI-UE). All medical records were anonymous; only statistical information was provided by Ibermutua for research purposes.

INCLUSION CRITERIA

We studied WREI that affects any ocular structure during work time and in itinere. These injuries were evaluated and classified by medical specialists according to CIE-9-MC classification, correlations with 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 analyzed 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 [3]. The occupational sector was classified according to the same Ministry's 2009 National Economic Activities Code (CNAE-2009 in Spanish), whereby occupational sector was divided into four groups: Agricultura, Industry, Construction, and Services [3].

STATISTICAL ANALYSIS

Quantitative variables are given as a mean ± standard deviation (SD). For qualitative variables, absolute and relative frequencies are given in percentages. To standardize data, the relationship between the number of WREI per 100,000 population in Ibermutua (ratio/100,000 population) was calculated. Ibermutua data was 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 analyze the relationship between WREI and sex, age and occupation. The risk of suffering WREI was calculated from the Odds Ratio (OR) obtained on this analysis taking as the reference the group with the lowest incidence.

The chi-square test and the Fisher exact test was used to analyze 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 Corp; Armonk, NY; USA), 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 ±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 5,349 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 4,273.36/100,000.

Workers insured by Ibermutua constituted an average of 5.81% (SD ±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 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 RELATIVE RISK (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 6.38-6.75) times more relative risk of suffering WREI than females (Table 2). If we analyze 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 ≥ 55 group (Table 2). The ≥ 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 1.71-1.83), 1.54 (95% CI 1.51-1.57), 1.38 (95% CI 1.35-1.41), and 1.17 (95% CI 1.13-1.21)) (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 ≥ 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 7.55-7.92) times higher in Industry workers, 6.94 (95% CI 6.77-7.12) times higher in Construction workers, and 1.53 (95% CI 1.45-1.61) 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 RELATIVE RISK (RR) PER 100,000 IBERMUTUA ACCIDENTS

WREI incidence was 5125.26 for males and 1762.18 for females, with a RR 2.91 (95% CI 2.83-299) 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 1.46-1.56)), followed by 25-34 age group (4800.23 and RR 1.43 (95% CI 1.40-1.46)), 35-44 age group (4364.93 and RR 1.30 (95% CI 1.27-1.33)), 45-54 years group (3729.39 y RR 1.11 (95% CI 1.07-1.15)), and, used as a reference and with the lowest incidence of all, the ≥ 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 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 3.74-3.92)), followed by Construction workers (6650; RR 2.54 (95% CI 2.48-5.60)), Agriculture

workers (4495.75; RR 1.72 (95% CI 1.64-1.81)), 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 79.61-80.61) more risk of suffering WREI than females. In addition, 16-24 age group showed the highest risk of suffering WREI compared to the lowest group (>55 years) (64.15% (95% CI 63.11-65.19)) and followed by the 25-34 age group (60.79% (CI 95% 59.93-61.65)), the 35-44 age group (58.24% (CI 95% 57.37-59.11) and the 45-54 age group (55.45% (CI 95% 54.50-56.39)).

Workers from the Industry group had the highest risk of suffering WREI compared with those from the Services group (85.29% (CI 95% 85.00-85.57)). They were followed by workers from the Construction (80.85% (CI 95% 80.43-81.26)) and Agriculture sectors (53.50% (CI 95% 52.33-54.93)).

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 relative risk (RR) was observed in males, aged between 16-24 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 Gomez Villa et al. observed in two villages on the island of Mallorca (Spain) (0.84%) [9], Torino (Italy) (1.3%) [10] and much lower than another with a similar number of study cases in the USA (3.4%) [11]. The difference was maybe due to the smaller area and population (only two villages and 50,851 workers) and the shorter study period (two years) 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 [4,5] and is very similar to that found by Karlsen et al. in Wisconsin (USA) in 1986 (423/100,000) [12]. 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) [13]. 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% [5,14–16]. A very similar RR was observed in Modena (Italy) (7:1 male/female ratio) [5], although it was lower in Taiwan (3.99) [14]. 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 [17].

35-44 was the most affected age group in our study. Our data match those found in an area in the southwest of China [16]. The highest percentage observed in other studies was in the 25-34 age group in Western Turkey [15] and the 16-24 age group in Modena (Italy) [5]. 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 analyzed 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 [5, 15, 18].

As in other studies [5], we observed the highest incidence and percentage of WREI in Industry workers. Agriculture was the most affected group in other studies [19,20] 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 [21].

When we analyzed the evolution of WREI for 100,000 Ibermutua insured/accidents, we standardized data and eliminated WREI due to population variation. Therefore, we need to find reasons for the reduction in WREI in all study variables. This generalized 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 this data could make it easier to devise specific programs 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 programs 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.

BIBLIOGRAPHY

1. Eurostat. Statistics Explained - Accidents at work statistics [Internet]. Eurostat Statistics Explained. 2015 [cited 2019 Oct 1]. p. 1–7. Available from: http://ec.europa.eu/eurostat/statistics-explained/
2. Eurostat. Health and safety at work in Europe (1999–2007) - A statistical portrait [Internet]. Publications Office of the European Union. 2010. 96 p. Available from: http://ec.europa.eu/eurostat/documents/3217494/5718905/KS-31-09-290-EN.PDF/88eef9f7-c229-40de-b1cd-43126bc4a946
3. 1Dirección General de Estadística y Análisis Sociolaboral D. Resumen. Estadística de Accidentes de Trabajo 2017 [Internet]. Ministerio de empleo y seguridad Social. 2017 [cited 2019 Oct 1]. p. 9. Available from: http://www.mitramiss.gob.es/estadisticas/eat/eat17/ATR_2017_Completa.pdf
4. Sahraravand A, Haavisto AK, Holopainen JM, Leivo T. Ocular traumas in working age adults in Finland – Helsinki Ocular Trauma Study. Acta Ophthalmol. 2017 May;95(3):288–94.
5. Gobba F, Dall'Olio E, Modenese A, De Maria M, Campi L, Cavallini GM. Work-related eye injuries: A relevant health problem. main epidemiological data from a highly-industrialized area of northern Italy. Int J Environ Res Public Health. 2017 Jun 6;14(6):604.
6. León Hernández FA, Taboada Esteve JF, Guimerá V, Gálvez-Martínez J, Pérez Salvador JL, Gil A, et al. Primer año del estudio multicéntrico español sobre traumatismos oculares. [Internet]. Vol. 60, Archivos de la Sociedad Epañola de Oftalmología. 1991 [cited 2019 Oct 2]. p. 79–88. Available from: https://dialnet.unirioja.es/servlet/articulo?codigo=6768620
7. Instituto Nacional de estadística (INE). España en cifras 2019 [Internet]. Publicaciones oficiales BOE. 2019 [cited 2019 Jul 30]. p. 1–60. Available from: http://www.ine.es/prodyser/espa_cifras/2019/2/index.html
8. Instituto Nacional de estadística (INE). Sección prensa / Encuesta de Población Activa (EPA). Serie histórica (Datos en miles de personas) [Internet]. 2014 [cited 2019 Dec 18]. Available from: https://www.ine.es/prensa/epa_tabla.htm
9. Gómez Villa P, Ladaria Lliteras A. Patología oftálmica en el medio laboral: ergooftalmología [Internet]. 2007 [cited 2019 Dec 28]. p. 1–85. Available from: http://diposit.ub.edu/dspace/bitstream/2445/7101/1/PATOLOGIA OFTALMICA.pdf
10. Fea A, Bosone A, Rolle T, Grignolo FM. Eye injuries in an Italian urban population: Report of 10620 cases admitted to an eye emergency department in Torino. Graefe's Arch Clin Exp Ophthalmol [Internet]. 2008 Feb;246(2):175–9.
11. Stagg BC, Shah MM, Talwar N, Padovani-Claudio DA, Woodward MA, Stein JD. Factors Affecting Visits to the Emergency Department for Urgent and Nonurgent Ocular Conditions. Ophthalmology [Internet]. 2017/01/31. 2017 May;124(5):720–9. Available from: https://pubmed.ncbi.nlm.nih.gov/28159379
12. Klein BEK. The Incidence of Acute Hospital-Treated Eye Injuries. Arch Ophthalmol. 1986 Oct 1;104(10):1473–6.
13. Yu TSI, Liu H, Hui K. A Case-Control Study of Eye Injuries in the Workplace in Hong Kong. Ophthalmology. 2004 Jan 1;111(1):70–4.
14. Ho CK, Yen YL, Chang CH, Chiang HC, Shen YY, Chang PY. Epidemiologic study on work-related eye injuries in Kaohsiung, Taiwan. Kaohsiung J Med Sci [Internet]. 2007 Sep;23(9):463–9. Available from: http://doi.wiley.com/10.1016/S1607-551X(08)70054-8
15. Serinken M, Turkcuer I, Cetin EN, Yilmaz A, Elicabuk H, Karcioglu O. Causes and characteristics of work-related eye injuries in western Turkey. Indian J Ophthalmol. 2013 Sep;61(9):497–501.
16. Cai M, Zhang J. Epidemiological characteristics of work-related ocular trauma in southwest region of China. Int J Environ Res Public Health. 2015 Aug 19;12(8):9864–75.
17. Instituto Nacional de estadística (INE). Encuesta de población Activa (EPA) 2018T4. [Internet]. Resultados Nacionales. Ocupados por grupo de edad, sexo y sector económico. 2018 [cited 2019 Mar 8]. Available from: http://www.ine.es/jaxiT3/Tabla.htm?t=3959 HYPERLINK "http://www.ine.es/jaxiT3/Tabla.htm?t=3959&L=0"& HYPERLINK "http://www.ine.es/jaxiT3/Tabla.htm?t=3959&L=0"L=0
18. Knyazer B, Bilenko N, Levy J, Lifshitx T, Belfair N, Klemperer I, Yabe T. Open globe eye injury characeristics and prognostic factors in Southern Israel: A retrospective epidemiologic review of 10 years experience. Isr Med Assoc J. 2013 Mar; 15(3):158-62

19. Jovanovic N, Peek-Asa C, Swanton A, Young T, Alajbegovic-Halimic J, Cavaljuga S, et al. Prevalence and risk factors associated with work-related eye injuries in Bosnia and Herzegovina. Int J Occup Environ Health. 2016 Oct 4;22(4):325–32.
20. Cruciani F, Lucchetta F, Regine F, Salandri Y, Abdolrahimzadeh B, Gabrieli B. Work–Related Accidents of Ophthalmologic Interest in Italy During 1986–1991. Ophthalmologica. 1997;211(4):251–5.
21. Forrest K, Cali JM. Epidemiology of lifetime Work-Related Eye Injuries in the U.S. Population associated with one or more lost days of work. Ophthalmic Epidemiol. May-Jun 2009;16(3):156-62. Avalaibel from: https://doi.org/10.1080/09286580902738175

CONTRIBUTORSHIP STATEMENT:

Alvarez-Peregrina, Villa-Collar and Sanchez-Tena designed the study.

Catalina-Romero and Calvo-Bonacho obtained the data.

The obtained data was analyzed by Martín-Prieto and Thuissard-Vasallo.

All authors contributed to the writing of the manuscript.

COMPETING INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this paper.

FUNDING

The authors received no financial support for the research, authorship, and/or publication of this article.

DATA SHARING STATEMENT

All data relevant to the study are included in the article or uploaded as supplementary information. Data are also available upon reasonable request.

Table 1: Total cases (N) of Ibermutua-insured, Ibermutua accidents and total WREI (Work-related eye injuries) according to sex, age and workers occupation. Losses: total number of losses out of total number of cases (50265) of WREI in all different groups.

	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	5,349	10.7		
Total	49,794	100	471	0.9
Age group WREI				
16-24	4,388	8.8		
25-34	14,981	29.9		
35-44	15,992	32.0		
45-54	10,278	20.5		
>55	4,390	8.8		
Total	50,029	100	236	0.5
Occupation WREI				
Agriculture	1,624	3.7		
Industry	18,899	42.6		
Construction	10,455	23.6		
Services	13,394	30.2		
Total	44,369	100	5,893	11.7

Table 2: Incidence of WREI over 100,000 insured and 1000,000 accidents and relative risk (RR) of 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
Sex							
Total	425.73		4253.29				
Male	680.13	80.11% (95% CI 79.61-80.61)	5125.27	6.56	6.38-6.75	2.91	2.83-2.99
Female	103.63	REF	1762.19	REF		REF	
Age							
Total	427.74		4273.36				
16-24 years	561.16	64.15% (95% CI 63.11-65.19)	5083.65	1.77	1.71-1.83	1.51	1.46-1.56
25-34 years	487.27	60.79% (CI 95% 59.93-61.65)	4800.23	1.54	1.51-1.57	1.43	1.40-1.46
35-44 years	435.58	58.24% (CI 95% 57.37-59.11)	4364.94	1.38	1.35-1.41	1.30	1.27-1,33
45-54 years	369.43	55.45% (CI 95% 54.50-56.39).	3729.40	1.17	1.13-1.21	1.11	1,.07-1.15
>55 Years	316.69	REF	3368.01	REF		REF	
Occupation							
Total	479.65		4719.61				
Agriculture	305.14	53.50% (CI 95% 52.33-54.93)	4495.75	1.53	1.45-1.61	1.72	1.64-1.81
Industry	1538.18	85.29% (CI 95% 85.00-85.57)	8050.69	7.73	7.55-7.92	3.83	3.74-3.92
Construction	1381.53	80.85% (CI 95% 80.43-81.26)	6650.00	6.94	6.77-7.12	2.54	2.48-2.60
Services	198.92	REF	2615.65	REF		REF	

Table 3. Relationship between WREI and study variables according to multivariate logistic regression analysis

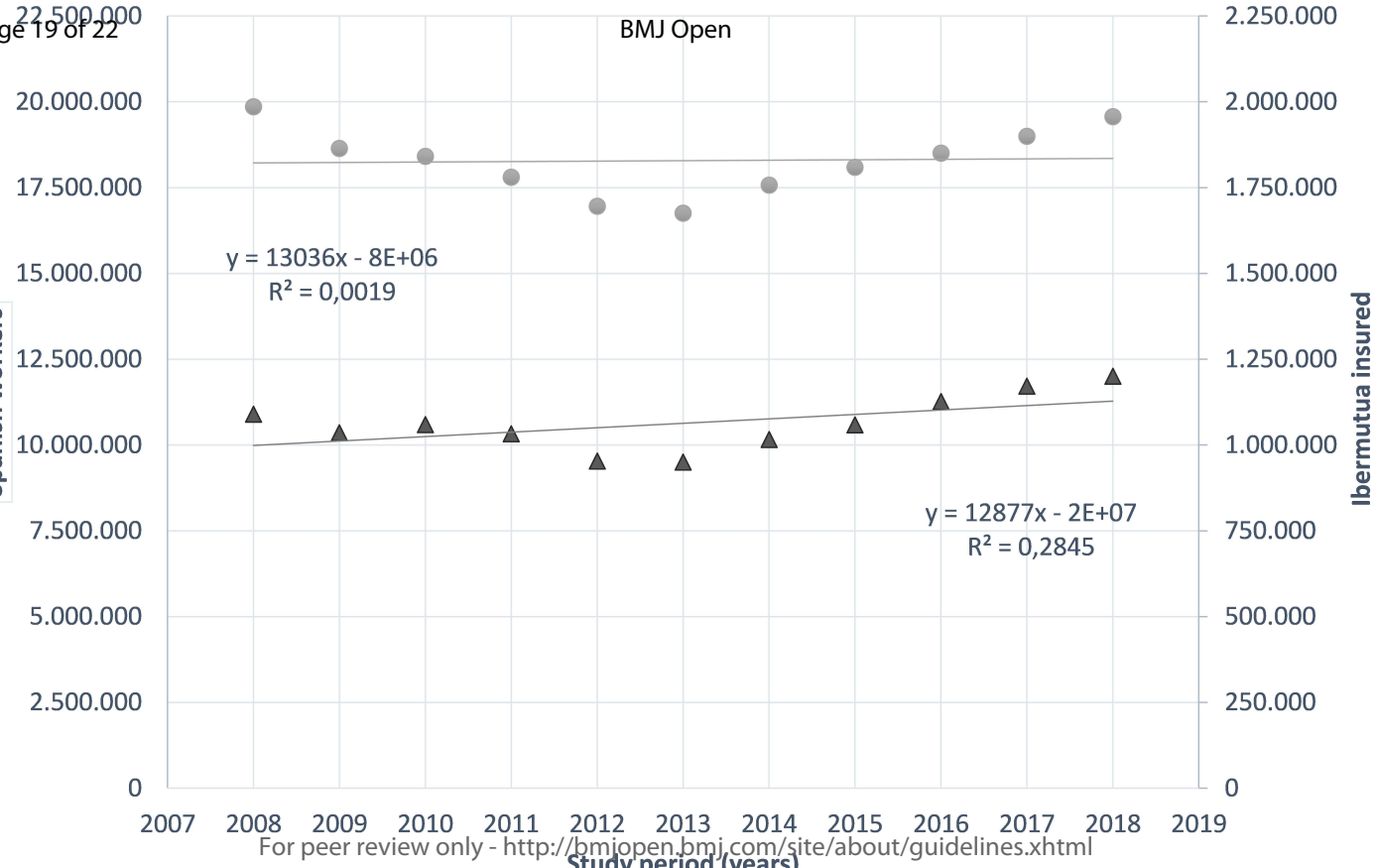
	OR (95% CI)	p-value
Sex		
Male	4,030(3,904-4,159)	< 0,001
Female	REF	REF
Age (years)		
16-24 years	1,790(1,711-1,873)	< 0,001
25-34 years	1,551(1,496-1,608)	< 0,001
35-44 years	1,395(1,346-1,446)	< 0,001
45-54 years	1,245(1,198-1,293)	< 0,001
>55 Years	REF	REF
Occupation		
Agriculture	1,151(1,098-1,219)	< 0,001
Industry	4,222(4,111-4,336)	< 0,001
Construction	5,799(5,668-5,933)	< 0,001
Services	REF	REF

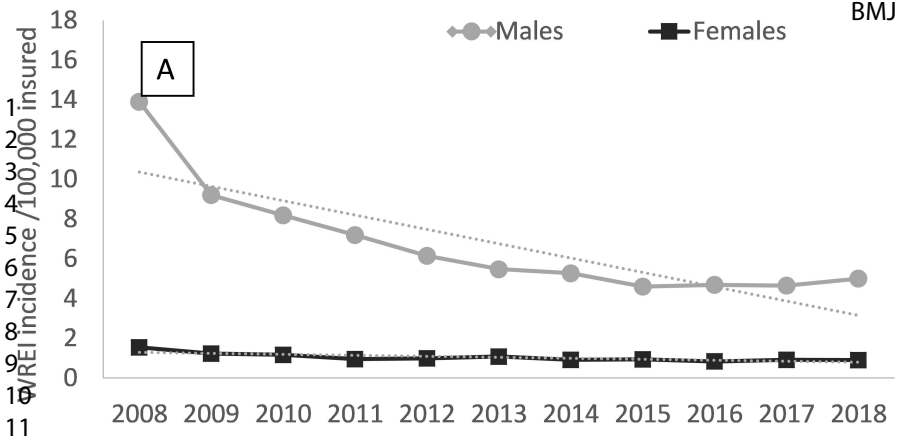
Figure Legends:

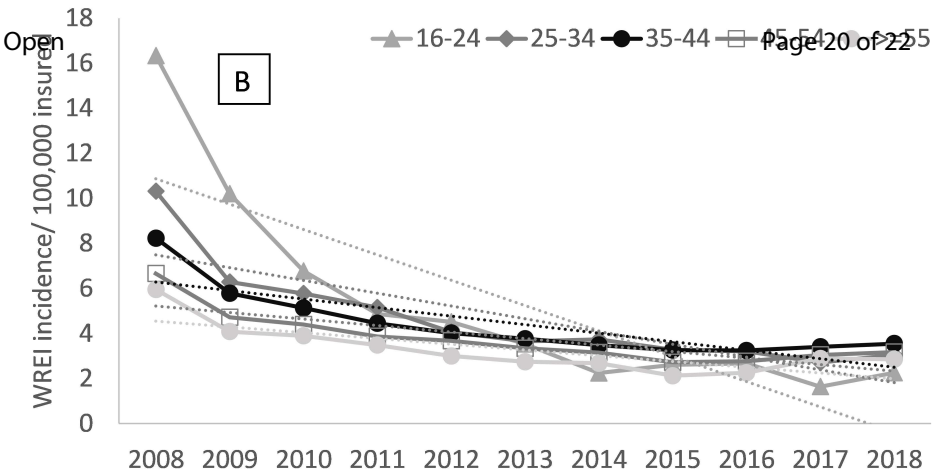
Figure 1: Relation between Ibermutua insured (triangle line) and Spanish workers (circle line) over the study period. There were no statistically significant differences in evolution over the 2008-2018 period (p=0.9987).

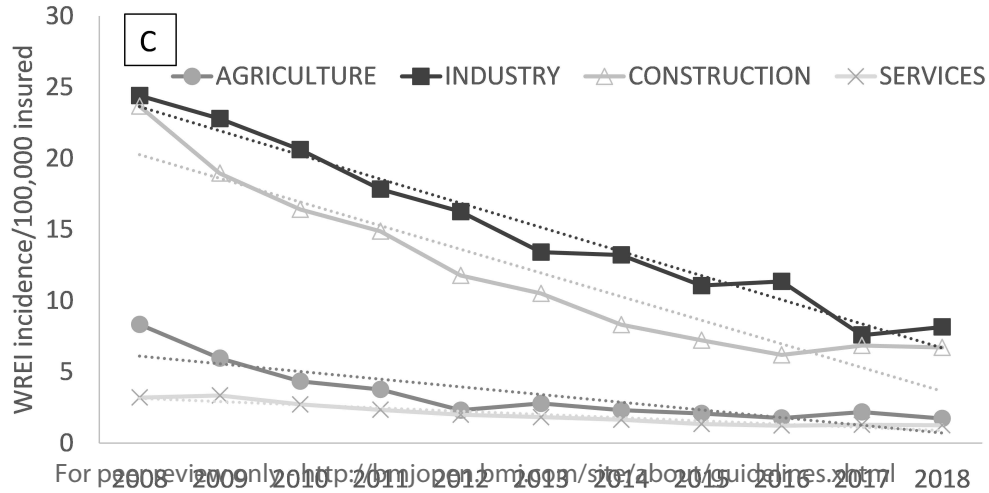
Figure 2: Evolution of WREI incidence per 100000 Ibermutua insured over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed.

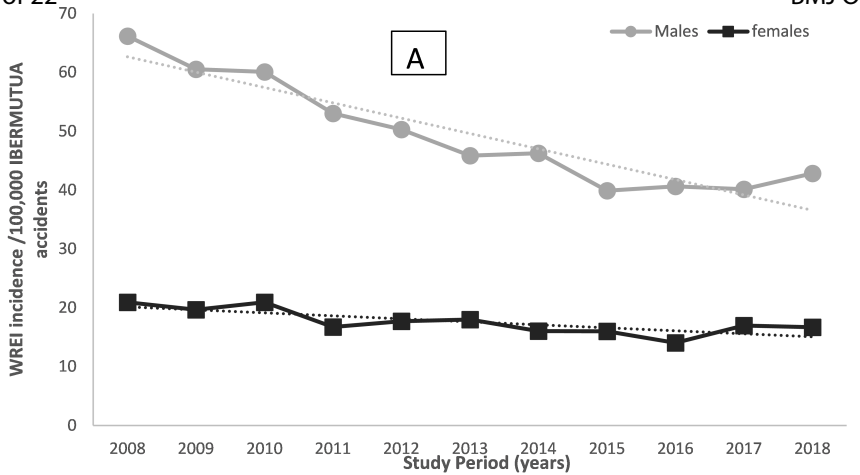
Figure 3: Evolution of WREI incidence per 100000 Ibermutua accidents over the study period. A decrease in incidence according to sex (A), age (B) and occupation (C) was observed.

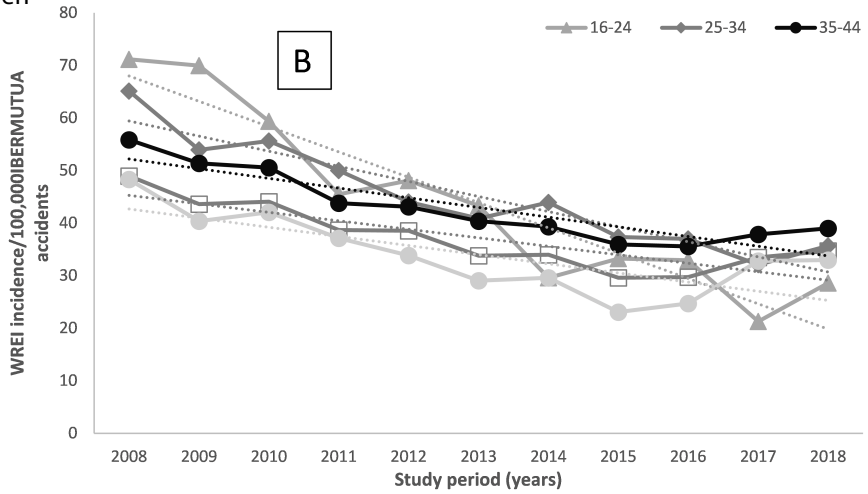


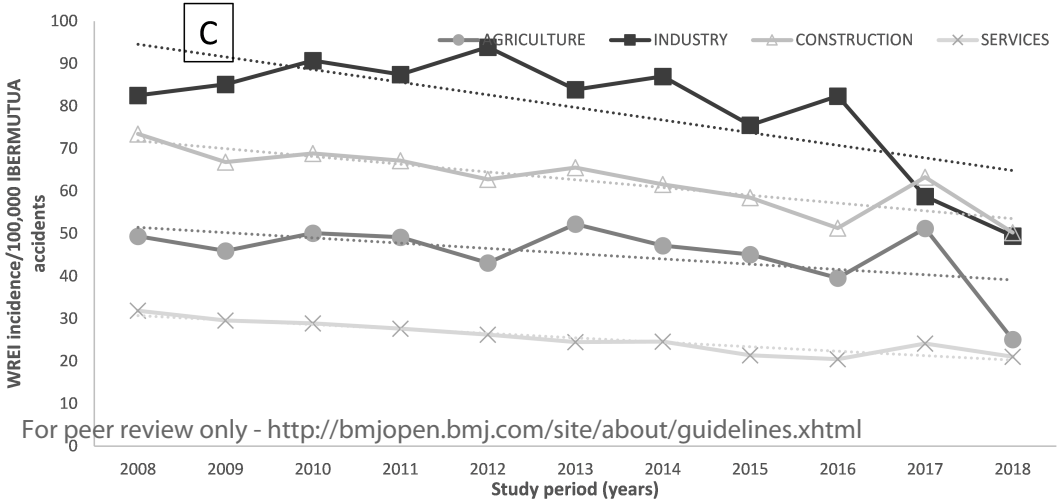












STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.