

## **On the issue of occupational pathology in the eyes of workers of the modern petroleum industry of Azerbaijan**

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[10.5281/zenodo.8004164](https://doi.org/10.5281/zenodo.8004164)

Received: March 10, 2023; Received in revised form: March 23, 2023; Accepted: March 30, 2023

The constant increase of the capacity of facilities used in the petroleum industry, their modernization as a whole necessitates a detailed study of the possible adverse effects of certain production factors on the organism of workers, including their ophthalmological status. The purpose of this research was to study the frequency of occurrence and the nature of possible changes in eye among workers of the modern petroleum industry. In total, 1852 employees from 13 enterprises of the State Oil Company of Azerbaijan Republic (SOCAR) were covered by a comprehensive ophthalmological examination in 2017-2019, taking into account age, work experience, severity of working conditions and exposure to harmful chemicals. A survey was conducted to identify the presence of complaints related to vision, chronic diseases, and contact during the work process with harmful chemicals. The degree of occupational causation of the identified diseases was determined based on the calculation of the absolute and relative risk, as well as the etiological fraction. It was found that 30% of workplaces belong to the high hazard class C (harmful working conditions), the most numerous were a group of people aged 50 to 59 years, the average age was  $48 \pm 2.3$  years; the average work experience of employees was  $19.3 \pm 1.7$  years. Of all respondents, 46.5% (861 people) had direct contact with harmful chemicals and petroleum in the process of work. The state of general ocular pathology was established in workers employed in the modern petroleum industry, 918 people (49.6% of all examined) had pathology in both eyes. In the structure of ophthalmopathology, the following nosologies were the most common: conjunctival and corneal diseases (AR=39%), various neoplasms of the eye and its adnexa (AR=26%) and refractive errors (AR=24%). The high level of etiological proportion and relative risk for conjunctival and corneal diseases (assuming  $2 < RR < 3.2$ , EF=33-50%), as well as for various eye neoplasms (assuming  $3.2 < RR < 5$ , EF=51-66%), make it possible to attribute these nosologies to work-related.

**Keywords:** *Occupational eye pathology, absolute risk, relative risk, etiological fraction, petroleum production*

### **ABBREVIATIONS**

SOCAR – State Oil Company of Azerbaijan Republic  
NCO – The National Center of Ophthalmology named after Academician Z. Aliyeva  
HCH – harmful chemicals

AR – absolute risk  
RR – relative risk  
EF – etiological fraction  
OU – both eyes  
OD – right eye  
OS – left eye  
PA - Production Association

## **INTRODUCTION**

The petroleum and petrochemical industry in Azerbaijan occupies a leading position and remains an important branch of the country's economy today (Askarova et al., 2012; Akhundova, 1998). Occupational pathology of the eyes has always been the focus of scientific research in our country and was most deeply studied by Academician Z.Aliyeva and her colleagues (1980, 1983, 1985, 1988). However, the constant increase in the capacity of facilities used in the petroleum industry, their modernization, in general, dictate the need for a detailed study of the possible adverse effects of some production factors on the organism of workers, including their ophthalmological status (WHO, 2016) Many publications state that some areas of the petroleum sector are still potentially dangerous for the health of workers (Janabayev et al., 2019, Rustamov, 2012, Blagun et al., 2018). In addition, the study of the causes and prevalence of eye diseases, the development of measures for their prevention, timely detection, reduction and treatment is one of the urgent tasks of medical science and healthcare. Publications in the scientific literature of the country on the assessment of individual occupational risks in a complex volume in the petrochemical industry are rare and fragmentary (Bagirov, 2004, Kasimov, 2017, Rustamov, 2012). Based on the above, early detection, investigation of the nature of changes, the study of eye pathology in workers in the modern petroleum industry, including depending on the harmfulness of working conditions, work experience and age, will allow an objective comprehensive assessment of their ophthalmological status.

The purpose of this research was to study the frequency of occurrence and the nature of possible changes in the eye among workers of the modern petroleum industry.

## **MATERIALS AND METHODS**

This cross-sectional study included an

analysis of the peculiarities of working conditions in the modern petroleum industry, a comprehensive assessment of the state of eye health of workers for 2017-2019 at the enterprises of the State Oil Company of Azerbaijan Republic (SOCAR). In total, the study covered 1852 employees from 13 SOCAR enterprises who agreed to the examination and questioning on a voluntary basis. The assessment of the ophthalmological status of workers employed in the modern petroleum industry was carried out using the methods of a comprehensive ophthalmological examination described by E.M.Kasimov (2017), such as visometry (using Huvitz Chart Projector CCP-3100 (HUVITZ Co, LTD, South Korea), biomicroscopy of the anterior segment of the eye (using slit lamp TOMEY TSL-5000, Tomey, Japan and portable slit lamp Reichert, Japan), measurement of intraocular pressure (applanate tonometer FT-1000 (TOMEY, Japan), refractometry (automatic keratorefractometer RC-5000 (TOMEY, Japan), ophthalmoscopy of the fundus (slit lamp TOMEY TSL-5000 (Tomey, Japan) using lenses (Ocular High Mag 78D, Ocular Instruments Inc., USA), etc. During assessing the ophthalmological status, a general clinical study was conducted at the workplace using a mobile clinic operating under the National Center of Ophthalmology named after academician Z.Aliyeva (NCO). The International Statistical Classification of Diseases and Related Health Problems 10<sup>th</sup> revision (ICD-X) was used for grouping by nosological groups. A survey was also conducted using the developed questionnaire, including, questions about complaints about vision, the presence of chronic diseases, or previous surgical interventions on the eyes, the presence of contact (direct or indirect) with harmful chemicals in the production process.

Age groups were subdivided on the basis of requirements and approaches to cross-sectional studies in industries ("18-29 years old", "30-45 years old", "46-59 years old", "60 years and older") (Obukhova et al., 2016; Petri, 2009); work experience is divided into three groups ("less than 5 years", "from 6 to 15 years", "over 16 years"). The severity of labour was assessed according to the HESCME principle (Health, Environment and

Social Capital Management in Enterprises) (Simon et al, 2012) and divided into three groups - "class A" - optimal conditions, "class B" - acceptable conditions and "class C" - harmful working conditions.

The degree of industrial conditionality of the detected diseases and health disorders of workers, depending on the work experience and working conditions, as well as on the presence of contact with harmful chemicals, was carried out based on the calculation of relative risk (RR relative risk, units). The relative risk values were estimated according to the methodological recommendations of Pavlovich T.P. et al. (2021) according to the formula:

$$RR = \frac{RF +}{RF -}$$

RF<sup>+</sup> - the risk of developing the disease in the presence of a risk factor,

RF<sup>-</sup> - the risk of developing the disease in the absence of a risk factor.

Etiological proportion, or the proportion of additional risk (EF, etiological fraction, units) - an indicator of the proportion of cases of eye disease and its adnexa under the exposure of the assessed risk factor in the total number of cases of detected diseases is calculated according to the formula (Pavlovich et al., 2021):

$$EF = \frac{AR}{RF +} * 100\%$$

AR<sup>-</sup> - the difference between RF<sup>+</sup> and RF<sup>-</sup>

RF<sup>+</sup> - the risk of developing the disease in the presence of a risk factor.

Absolute risk (AR) is the proportion of working with identified ophthalmopathologies from the total volume of the group. AR was calculated for both exposed (exposed to the factor – contact with harmful chemicals) and non-exposed persons. AR expresses the risk of developing the disease in the presence (or

absence) of the factor and corresponds to the prevalence of diseases.

According to the manual on occupational health risk for workers (2004), as well as the reports of N.F.Izmerov and I.V.Bukhtiyarov (2018), and all ophthalmopathologies detected during the study were classified as general, occupational conditioned and occupational diseases (Table 1). The relative risk values were evaluated according to the parameters recommended in Table 2.

## RESULTS AND DISCUSSION

The study of working conditions showed that 55.5% of workplaces in the enterprises belong to class A (optimal working conditions). However, the picture has changed for enterprises; for example, modern petroleum industry enterprises with good working conditions include departments (Bibi-Heybat, the head office of “SOCAR”, department of Petroleum and Gas Production named after N.Narimanov, PA «Azpetrol» and Educational and Methodological Department of Certification "SOCAR"). On average, 30% of workplaces belong to the high-hazard class C (harmful working conditions) (mainly "Petroleum rocks" and "Siyazan-petroleum").

The distribution of employees by age showed that the most numerous (41.5%) was a group of people aged 50 to 59 years. The average age of employees was 48 years (min=19; max=67; Me=50; Mo=56).

In our study, it was found that the most widely represented group with over 16 years of work experience (57.1% of all surveyed). Moreover, this trend is not observed for all surveyed enterprises.

**Table 1.** Assessment of the degree of causal-effect relationship of health disorders with work (according to epidemiological studies) (by P2.2.1766-03 Минздрав России, М., 2004)

0<RR<1	1<RR<1.5	1.5<RR<2	2<RR<3.2	3.2<RR<5	RR<5
EF=0	EF< 33%	EF=33-50%	EF=51-66%	EF=67-80%	EF=81-100%
Null	Small	Medium	High	Very high	Almost full
General diseases		Occupational conditioned disease		Occupational diseases	

**Table 2.** Estimation of relative risk values

RR	Interpretation
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<b>RR&lt;1</b>	The risk of getting sick in exposed persons is lower than in those who were not affected by the studied factor, therefore, this factor probably has a beneficial effect on health
<b>RR= 1</b>	There is no connection between the studied factor and the disease
<b>RR&gt;1</b>	The risk of getting sick in the presence of the studied factor is higher than in its absence, therefore this factor is damaging, i.e. a risk factor and leads to illness

So, for example, in such organizations as the “Siyazan-Petroleum” petroleum and gas production Plant, the Department of Petroleum and Gas Production named after Amirov and the Bibi-Heybat Petroleum and Gas Production Department had a high percentage of highly-qualified employees and amounted to 90.7, 76.8 and 69.0%, respectively. The total average work experience of the surveyed employees is 19.3±1.7 years. Thus, the study found that at most of the surveyed petroleum facilities, the overwhelming majority were specialists with high work experience.

The study of the opinion of workers in the modern petroleum industry showed that 46.5% (861 people) of all respondents have direct contact with harmful chemicals and petroleum in the process of work. At the same time, 30.5% of respondents noted the presence of indirect contact with harmful substances. Of all the respondents, 23% noted the absence of contact with harmful chemicals. The results of ranking the 10 main frequency ranks of groups of harmful chemicals to which workers of the modern oil industry are exposed during professional contact showed that most often - in 244 cases (56.1±4.8% of all indicated groups of HCH) workers in modern oil production have to come into contact with oil and oil products. The second place is given to gas and various gas condensates (30.3±3.4%). Only 3 respondents indicated contact with heavy metals during work which amounted to 0.7±0.01% of all these groups of harmful substances. It has been established that in class A production conditions, contact with harmful chemicals is completely absent. In class B production conditions, contact with various aromatic hydrocarbons, salts, alkalis, acids and sulfur compounds accounted for 30% of positive responses each. Thus, the possible exposure to harmful chemicals is still present in enterprises despite the modernization of the studied industries. In addition, as many native and foreign authors point out (Alieva, 1985; Akhundova, 1998; Blagun et al., 2018), office work, work outdoors, indoors with insufficient

illumination indirectly can also be provoking factors in the formation of ocular pathology. According to our data, in the production group of class A, out of 398 detected cases, ocular diseases in 341 (88%) were observed in the form of isolated and 55 (12%) - in comorbidity. The studied pathology of the eye occurs 2 times more often (RR=1.7, CI 0.79-0.91, p<0.005) among workers employed in hazardous working conditions than those employed in optimal conditions of severity.

The calculation of extensive indicators revealed that among all examined workers, 307 (33.4±4.1%) workers who had contact with HCH during the production process had various diseases of the eye. In 124 (13.3±0.9%) examined patients despite the presence of HCH exposure no eye pathology was found.

Among the workers of the modern petroleum industry the frequency of practically healthy according to self-assessment data, was 1,739 people (93.9% of all surveyed). In the structure of morbidity from the anamnesis of the remaining 113 surveyed workers of the modern petroleum industry presence of diabetes mellitus was most often noted – in 68 people (60.2%) and arterial hypertension – in 32 (28.3%). 7% of the surveyed indicated the presence of various allergic conditions. Our studies have established the state of general eye pathology in workers employed in the modern petroleum industry (Table 3). Thus, 918 people (49.6% of all examined) had pathology in both eyes, of which 83% were isolated and 17% were combined.

Table 3 shows that 91 examined patients had pathology of the right eye of which 97.8% were isolated and 2.2% were combined. In 121 people pathology of the left eye was revealed: 99.2% – isolated and 0.8% – combined. In this regard, it was interesting for us to study the structure and features of pathology in both eyes.

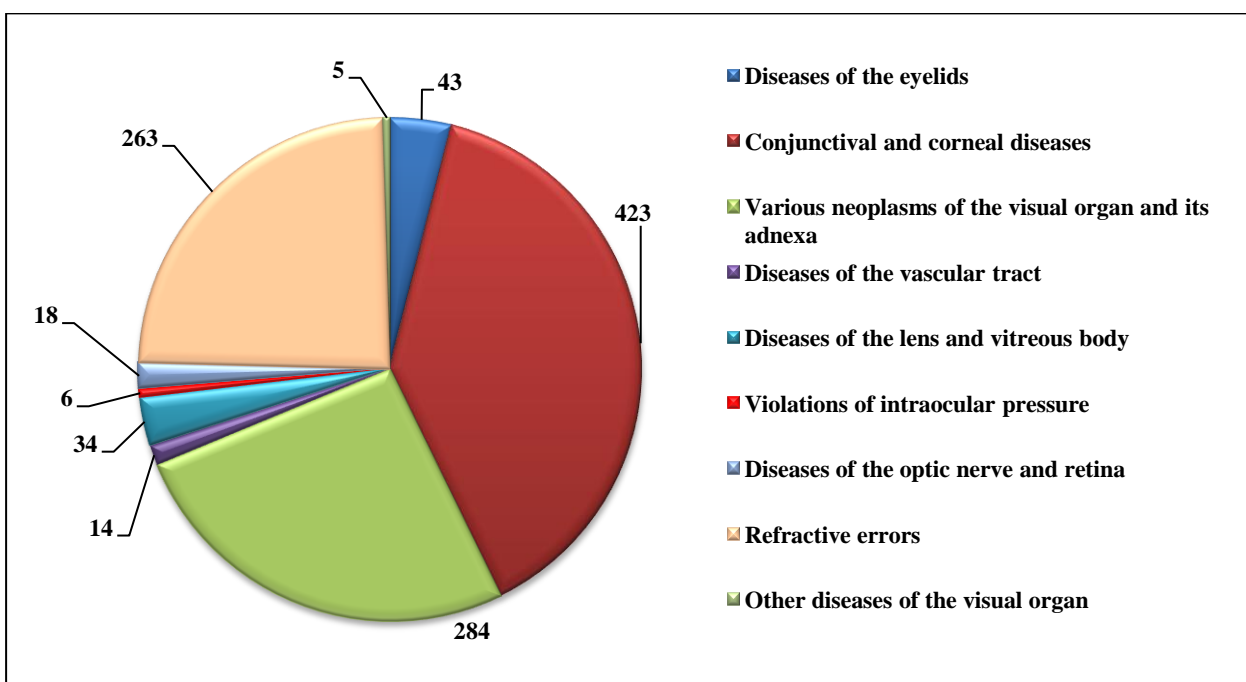
The structure of the general isolated and combined pathology of both eyes in workers of the modern petroleum industry is shown in Figure.

Figure clearly demonstrates a wide range of pathology of the eye in workers of the modern petroleum industry. Based on our obtained data, the following nosologies have the highest proportion in the structure of ophthalmological morbidity among the examined: conjunctival and corneal diseases (absolute risk is 39%), various

neoplasms of the eye and its adnexa (AR=26%) and refractive errors (AR=24%), and statistically reliably traced the frequency of various eye neoplasms depends on exposure to harmful chemicals ( $\chi^2=5.7, p<0.05$ ) and on the severity of labor ( $\chi^2=4.9, p<0.05$ ).

**Table 3.** Revealed pathology of eyes in workers of the modern petroleum industry

Pathology of the eyes		Examined workers (N=1852)	
		abs.number	%
OU	Not identified	934	
	Isolated	918	762
	Combined		156
OD	Not identified	1761	
	Isolated	91	89
	Combined		2
OS	Not identified	1731	
	Isolated	121	120
	Combined		1



**Fig.** The share distribution of the general pathology of both eyes among workers of the modern petroleum industry.

The studies also found that despite minor changes in the proportion of the main leading ophthalmological pathologies depending on the work experience and the age of the examined, the absolute risk of combined pathologies increased with the increase in the work experience of those

who worked reaching a maximum in the high experience of examined (AR=9.8%) and in the distribution by age groups – in the group "over 60 years" (AR=21.6%).

Among ophthalmopathologies, a statistically significant dependence of detection rate on work

experience was found ( $p < 0.005$ ). Thus, the frequency of detecting pathologies of the eye is 2.1 times higher for workers with more than 16 years of work experience compared with workers with 6-15 years of work experience ( $RR=1.4$ ,  $CI$  0.59-0.83,  $p < 0.005$ ).

Thus, our studies once again confirmed the fact that despite minor changes in the proportion of the main leading ophthalmological pathologies depending on the work experience, the percentage of comorbidities increased with the work experience of those working at modern petrochemical production enterprises, reaching a maximum in the highly trained group of examined (21.6%).

According to the manual on occupational health risk for workers (Guidance on occupational health risk assessment for workers, 2004), based on the calculations, the degree of causal-effect relationship between the influence of harmful substances in the process of work and the occurrence of various pathologies of the eye was estimated by us as high and very high for eye neoplasms (provided  $3.2 < RR < 5$ ,  $EF=51-66\%$ ) that allows us to consider the studied nosologies as work-related diseases for the petroleum industry. Value of the relative risk for the occurrence of refractive errors equal to one ( $RR=1$ , assuming  $EF < 33\%$ ) shows the absence of a causal-effect relationship with both work experience and dependence on contact with HCH. In general, the application of risk analysis of certain production factors in ophthalmology will allow us to solve a number of important tasks in the future such as developing a mechanism and strategy for various regulatory measures to reduce it; obtaining quantitative characteristics of potential and real damage to health from the impact of adverse production factors; promote the establishment of more reliable safe levels and hygienic standards and others.

## CONCLUSIONS

1. At modern petroleum production, the absolute risk of such eye pathologies as conjunctival and corneal diseases ( $AR=39\%$ ), refractive errors ( $AR=24\%$ ) and various neoplasms of the eye and its adnexa ( $AR=24\%$ ) was the

highest.

2. The high level of etiological fraction and relative risk for conjunctival and corneal diseases as well as for various eye neoplasms make it possible to attribute the studied nosologies to occupational eye pathologies.

## ACKNOWLEDGEMENTS

This article and the research underlying it would not have been possible without the exceptional support of the staff of the National Center of Ophthalmology named after Academician Z.Aliyeva as well as the staff of the mobile clinic operating at the NCO.

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\***Citation:** Kasimov Eldar, Ibrahimova Sona (2023) On the issue of occupational pathology in the eyes of workers of the modern petroleum industry of Azerbaijan. *Journ. Life Sci. & Biomed.*, **78(1)**: 19-25

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