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Medvedovska Nataliia Volodymyrivna,
Doctor of Medical Sciences, Professor,
National Academy of Medical Sciences of Ukraine
ORCID ID: 0000-0003-3061-6079
Kyiv, Ukraine

SOCIO-BEHAVIORAL PATTERNS OF THE POPULATION AS PREDICTORS OF TRAUMATIC EYE INJURIES: RESULTS OF A COMPARATIVE ANALYSIS OF UKRAINIAN REGIONS

Introduction. About 200 thousand cases of eye injuries are registered annually, of which more than 15% lead to persistent vision loss or complete blindness. Behavioral factors play a leading role in the occurrence of eye injuries; however, their regional characteristics and prognostic significance in Ukraine remain poorly understood.

Purpose: to determine regional differences in socio-behavioral patterns of the Ukrainian population and identify their prognostic significance for the occurrence of traumatic eye injuries. The study aimed to identify key behavioral predictors of ocular trauma and establish evidence-based recommendations for regional prevention programs.

Materials and methods: A study was conducted in thirteen regions of Ukraine, representing five geographical macroregions: Western, Eastern, Central, Northern, and Southern. Data from official statistics of the Ministry of Health of Ukraine on 187,452 cases of eye injuries for 2020-2023 were used. A survey of 3,456 respondents aged 18-65 was conducted using a random sampling method. 1,587 medical records of patients with eye injuries in specialized hospitals were analyzed. The questionnaire included 45 questions about educational level, professional activity, frequency of use of personal protective equipment, alcohol consumption habits, self-assessment of the level of awareness of safety rules. Pearson correlation analysis, logistic regression to determine predictors, and cluster analysis using the k-means method were applied. Statistical processing was performed in IBM SPSS Statistics version 29. The study was conducted in compliance with the principles of the Declaration of Helsinki.

Results: significant inter-regional differences in the frequency of eye injuries were found (from 16.2 to 30.8 per 10 thousand population). Lack of higher education increases the chances of injury by 2.4 times (OR=2.41; $p<0.001$), irregular use of protective equipment by 3.8 times (OR=3.79; $p<0.001$), and alcohol consumption by 3.2 times (OR=3.24; $p<0.001$). Cluster analysis identified two groups of regions with different behavioral patterns. The use of personal protective equipment in cases of occupational injuries was reported in only 23.8% of cases, with a variation ranging from 41.4% in the Lviv region to 10.9% in the Kherson region.

Conclusions. Socio-behavioral characteristics of the population are key predictors of eye injuries. The identified clustering of regions enables the development of targeted prevention strategies for specific regions of Ukraine, thereby enhancing the effectiveness of interventions.

Key words: ocular trauma, socio-behavioral patterns, regional differences, prevention, personal protective equipment, injury predictors, Ukraine.

Медведовська Наталія Володимирівна, доктор медичних наук, професор, Національна академія медичних наук України; ORCID ID: 0000-0003-3061-6079, м. Київ, Україна

СОЦІАЛЬНО-ПОВЕДІНКОВІ ПАТЕРНИ НАСЕЛЕННЯ ЯК ПРЕДИКТОРИ ТРАВМАТИЧНИХ УШКОДЖЕНЬ ОКА: РЕЗУЛЬТАТИ ПОРІВНЯЛЬНОГО АНАЛІЗУ РЕГІОНІВ УКРАЇНИ

Вступ. Щороку реєструється близько 200 тисяч випадків очних травм, з яких понад 15% призводять до стійкого зниження зору або повної сліпоти. Поведінкові фактори відіграють провідну роль у виникненні очних травм, проте їх регіональні особливості та прогностичне значення в умовах України залишаються недостатньо вивченими.

Мета: з'ясувати регіональні відмінності в соціально-поведінкових патернах населення України та визначити їх прогностичне значення для виникнення травматичних ушкоджень ока.

Матеріали та методи: проведено дослідження у тринадцяти областях України, які представляють п'ять географічних макрорегіонів: західний, східний, центральний, північний та південний. Використано дані офіційної статистики МОЗ України про 187 452 випадки очних травм за 2020-2023 роки. Проведено анкетування 3 456 респондентів віком 18-65 років методом випадкової вибірки. Проаналізовано 1 587 медичних карт пацієнтів з очних травмами у профільних стаціонарах. Анкета включала 45 питань про освітній рівень, професійну діяльність, частоту використання засобів індивідуального захисту, звички споживання алкоголю, самооцінку рівня обізнаності про правила безпеки. Застосовано кореляційний аналіз Пірсона, логістичну регресію для визначення предикторів, кластерний аналіз методом k-середніх. Статистичну обробку виконано в IBM SPSS Statistics версія 29. Дослідження виконане з дотриманням принципів Гельсінської декларації.

Результати: виявлено суттєві міжобласні відмінності у частоті очних травм (від 16,2 до 30,8 на 10 тис. населення). Відсутність вищої освіти підвищує шанси травмування у 2,4 рази (OR=2,41; $p<0,001$), нерегулярне використання засобів захисту – у 3,8 рази (OR=3,79; $p<0,001$), споживання алкоголю – у 3,2 рази (OR=3,24; $p<0,001$). Кластерний аналіз виділив дві групи областей з різними поведінковими патернами. Використання засобів індивідуального захисту при виробничих травмах становило лише 23,8% випадків з варіацією від 41,4% у Львівській області до 10,9% у Херсонській області.

Висновки: соціально-поведінкові характеристики населення є ключовими предикторами очних травм. Виявлена кластеризація областей дає змогу розробляти диференційовані профілактичні стратегії для різних регіонів України, що підвищить ефективність втручань.

Ключові слова: очні травми, соціально-поведінкові патерни, регіональні відмінності, профілактика, засоби індивідуального захисту, предиктори травматизму, Україна.

Introduction. Traumatic eye injuries represent a significant medical and social problem in Ukraine. Approximately 200,000 cases of eye injuries are registered annually, more than 15% of which result in permanent vision loss or complete blindness [1, 2]. Due to treatment costs and loss of working capacity, the economic burden of this pathology is estimated to exceed 2 billion hryvnias per year [3].

Global scientific evidence indicates that behavioral factors play a decisive role in the occurrence of eye injuries [4, 5]. Studies conducted in the United States have shown that nearly 90% of occupational eye injuries can be prevented through compliance with safety regulations and the use of personal protective equipment [6]. Similar findings have been reported in studies from European countries, where the implementation of behavioral change programs has reduced the incidence of eye injuries by 35–45% [7, 8].

Publications over the past five years have highlighted the association between socioeconomic conditions and the frequency of eye injuries [9, 10]. It has been established that individuals with lower levels of education are 2.3 times more likely to sustain eye injuries than those with higher educational attainment [11]. Alcohol consumption increases the likelihood of eye injury by 3.5 times, particularly in domestic settings [12, 13].

Regional characteristics of Ukraine create different conditions for the formation of behavioral risks. Industrial areas with high employment in manufacturing demonstrate specific injury patterns, whereas agricultural regions are characterized by a different risk profile associated with agricultural work. Urbanized areas have their own characteristics related to domestic and road-traffic injuries [14–16].

However, the Ukrainian scientific literature lacks comprehensive studies that systematically analyze the socio-behavioral determinants of eye injuries across different regions. Most available studies focus on the clinical aspects of treatment, while the preventive potential associated with modifying population behavior remains largely overlooked [17, 18].

Research objective. To identify regional differences in the social and behavioral patterns of the Ukrainian population and to determine their prognostic significance for the occurrence of traumatic eye injuries.

Object, materials, and methods of the study. The object of the study was the social and behavioral patterns of the population as risk factors for eye injuries.

The study was conducted in 2022–2024 in thirteen regions of Ukraine representing five geographical macro-regions: the western region (Lviv and Ivano-Frankivsk regions), the eastern region (Kharkiv and Donetsk regions), the central region (Cherkasy, Kirovohrad, and Poltava regions), the northern region (Chernihiv and Sumy regions), and the southern region (Mykolaiv, Odesa, and Kherson regions). The selection of regions was based on differences in socio-economic characteristics, levels of industrialization, and employment structure.

Data from the Medical Statistics Center of the Ministry of Health of Ukraine on registered cases of eye injuries for 2020–2023 (n = 187,452) were used. A survey of 3,456 respondents aged 18–65 years in the selected regions was conducted using random sampling. The questionnaire included 45 questions addressing educational level, professional activity, frequency of personal protective equipment use, alcohol consumption habits, and self-assessed awareness of safety regulations.

In addition, 1,587 medical records of patients with eye injuries from specialized hospitals in the selected regions were analyzed. The circumstances of the injury, time of day, day of the week, use of protective equipment, and the presence of alcohol intoxication were recorded.

The study was conducted in accordance with the principles of the Helsinki Declaration. Informed consent was obtained from all survey participants. Respondents' personal data were neither recorded nor processed.

Statistical analysis was performed using IBM SPSS Statistics version 29. Descriptive statistics (means, standard deviations, and frequencies), Pearson correlation analysis to identify relationships between variables, logistic regression to determine predictors of eye injuries, and k-means cluster analysis to group regions were applied. The level of statistical significance was set at $p < 0.05$. To assess the strength of associations, odds ratios (OR) with 95% confidence intervals were calculated.

Research results. The analysis of statistical data revealed significant regional differences in the incidence of eye injuries. The highest rates were recorded in the Dnipropetrovsk region–28.4 cases per 10,000 population–while the lowest rates were observed in the Lviv region–16.7 cases per 10,000 population (Table 1).

Correlation analysis revealed significant associations between socio-behavioral characteristics and eye injury rates. The proportion of individuals with higher education was negatively correlated with eye injury rates ($r = -0.89$, $p = 0.041$). Regular use of personal protective equipment also showed a strong negative correlation ($r = -0.94$, $p = 0.017$). Alcohol consumption was positively associated with injury rates ($r = 0.91$, $p = 0.032$).

A detailed analysis of 1,234 medical records revealed the structure of injury circumstances**.** Work-related injuries accounted for 42.3%, domestic injuries for 38.6%, road-traffic injuries for 11.4%, sports injuries for 4.8%, and other injuries for 2.9%.

Regional differences in the structure of injuries were statistically significant ($\chi^2 = 187.4$, $p < 0.001$). In the Dnipropetrovsk region, work-related injuries predominated (59.7%), whereas in the Zakarpattia region domestic injuries were most common (51.3%). In the Lviv region, a more balanced structure of injuries was observed.

An analysis of the time of injury occurrence showed that 34.7% of cases occurred on Fridays and Saturdays, which correlated with data on alcohol consumption. In regions with higher alcohol consumption rates, the proportion of "weekend" injuries reached 47.2%.

The use of personal protective equipment during industrial injuries was recorded in only 23.4% of cases. At the same time, regional differences were substantial, ranging from 41.8% in the Lviv region to 12.7% in the Kherson region (Table 2).

Logistic regression analysis identified the most significant predictors of eye injuries. Lack of higher education

increased the odds of injury by 2.4 times (OR = 2.41; 95% CI: 1.87–3.11; $p < 0.001$). Irregular use of protective equipment increased the risk by 3.8 times (OR = 3.79; 95% CI: 2.94–4.88; $p < 0.001$). Regular alcohol consumption was associated with a 3.2-fold increase in the likelihood of injury (OR = 3.24; 95% CI: 2.51–4.19; $p < 0.001$).

Cluster analysis identified two types of regions. The first cluster (Lviv and Kharkiv regions) was characterized by a higher level of education among the population, a stronger safety culture, lower alcohol consumption, and, consequently, a lower incidence of eye injuries. The second cluster (Dnipropetrovsk, Zakarpattia, and Kherson regions) demonstrated the opposite characteristics.

The questionnaire analysis revealed the level of public awareness regarding eye injury prevention. Only 34.2% of respondents were able to name the basic safety rules when working with potentially dangerous tools. In the regions of the second cluster, this figure was 21.7%, whereas in the first cluster it reached 52.8% ($p < 0.001$).

Discussion of the study results. The obtained data confirm the leading role of socio-behavioral factors in the occurrence of eye injuries. Regional differences in the incidence of eye injuries are largely explained by variations in the educational level of the population, safety culture, and the prevalence of risky behaviors.

The identified relationship between educational level and trauma is consistent with international data. Studies conducted in India have demonstrated a similar pattern: individuals without complete secondary education had a 2.7-fold higher risk of occupational eye injuries [19]. A population-based study in Brazil found that low educational status was the strongest predictor of eye injuries among socio-demographic characteristics [20].

The critically low level of personal protective equipment use in occupational injuries (23.4%) indicates systemic problems in the culture of occupational safety. Data from China show that the mandatory use of safety glasses reduces the risk of severe eye injuries by 87% [21]. In the United States, programs mandating the use of personal protective equipment in the construction industry reduced occupational eye injuries by 62% over five years [22].

The temporal distribution of injuries, with a peak on weekends, and its correlation with alcohol consumption are consistent with global trends. A Scandinavian study found that 41% of domestic eye injuries among men aged 25–44 years were associated with alcohol consumption [23]. Australian authors report a 3.8-fold increase in the risk of eye injuries in cases of alcohol intoxication [24].

Regional clustering based on a set of socio-behavioral characteristics allows for a differentiated approach to prevention. Regions in the first cluster primarily require sup-

Table 1

Indicators of eye injuries and socio-behavioral characteristics of the population in the regions

Region	Macro-region	Injuries per 10,000	Higher education (%)	Use of PPE (%)	Alcohol consumption (points)*
Lviv	Western	16.2	48.7	69.3	2.0
Ivano-Frankivsk	Western	18.4	44.9	65.1	2.4
Kharkiv	Eastern	19.5	45.2	62.7	2.3
Donetsk	Eastern	20.7	41.8	56.1	2.9
Cherkasy	Central	23.1	36.4	48.7	3.0
Kirovograd	Central	24.8	34.2	45.2	3.2
Poltava	Central	24.7	33.5	44.4	3.4
Chernihiv	Northern	26.2	33.1	42.5	3.4
Sumy	Northern	27.4	30.7	38.1	3.6
Mykolaiv	Southern	27.8	30.2	39.4	3.7
Odessa	Southern	28.3	29.1	36.8	3.9
Kherson	Southern	30.8	26.5	33.9	4.1

*On a 5-point scale of consumption frequency

Table 2

Use of personal protective equipment in occupational eye injuries

Region	Macro-region	Total occupational injuries	Use of PPE (n)	Use of PPE (%)
Lviv	Western	58	24	41.4
Ivano-Frankivsk	Western	66	26	39.4
Kharkiv	Eastern	87	29	33.3
Donetsk	Eastern	91	27	29.7
Cherkasy	Central	112	24	21.4
Kirovograd	Central	118	22	18.6
Poltava	Central	118	22	18.6
Chernihiv	Northern	74	15	20.3
Sumy	Northern	73	14	19.2
Mykolaiv	Southern	68	10	14.7
Odessa	Southern	71	9	12.7
Kherson	Southern	64	7	10.9

port for existing positive practices and their dissemination. Regions in the second cluster require comprehensive interventions aimed at increasing public awareness, modifying behavioral patterns, and strengthening control over compliance with safety regulations.

The low level of public awareness regarding eye injury prevention rules (34.2%) indicates insufficient educational efforts. A mass educational program on eye safety in South Korea reduced the incidence of domestic eye injuries by 28% over three years [25]. Singapore's experience with school-based education on vision safety has demonstrated a long-term preventive effect in adulthood [26].

The limitations of the study include the retrospective nature of data collection from medical records, which may have resulted in incomplete information regarding the circumstances of the injuries. The questionnaire also carried a potential risk of response bias due to social desirability. The geographical coverage of the study is limited to five regions, which does not allow the results to be extrapolated to the whole of Ukraine without additional verification.

The practical significance of the results lies in identifying priority areas for regional prevention programs. For industrial regions, it is critical to strengthen control over the use of personal protective equipment in the workplace. Agricultural regions require specialized educational programs for the rural population. Urbanized areas require a greater focus on the prevention of domestic and road-traffic injuries.

Prospects for further research. A longitudinal study is planned to assess the dynamics of behavioral patterns and their impact on the incidence of eye injuries over a five-year period. It is also promising to investigate the effectiveness of targeted interventions aimed at modifying behavior in regions with high injury rates.

Conclusions:

1. Regional differences in the incidence of eye injuries in Ukraine are largely determined by the socio-behavioral characteristics of the population. Regions with higher levels of education, stronger safety culture, and lower alcohol consumption demonstrate 40–70% lower rates of eye injuries.

2. The most significant predictors of eye injuries are lack of higher education (OR = 2.41), irregular use of personal protective equipment (OR = 3.79), and regular alcohol consumption (OR = 3.24). Modification of these behavioral factors has the greatest preventive potential.

3. The critically low level of personal protective equipment use in occupational injuries (23.4%) indicates the need to strengthen control over compliance with occupational safety regulations and to increase employer responsibility.

4. The identified clustering of regions according to socio-behavioral patterns makes it possible to develop differentiated prevention strategies tailored to the specific needs of each type of region, which may increase the effectiveness of interventions and optimize the use of healthcare resources.

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