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REFRACTIVE ERRORS AND OCULAR TRAUMA IN MILITARY FORCES AS FACTORS OF AWARENESS AND SOCIOECONOMIC IMPACT

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The purpose of the study was to assess, across different military contingents, the level of awareness regarding refractive errors, ophthalmic trauma and their correction, first-aid behaviours, and knowledge related to enhancing the long-term effectiveness of refractive laser procedures in the context of their potential impact on military service preparedness and the state budget. A cross-sectional questionnaire survey was conducted among 20–35-year-old service members serving in various military structures of Azerbaijan. In total, 450 respondents (mean age 25.4 years) participated; of these, 205 (45.6 %) belonged to the military-medical education group and 245 (54.4 %) to the group without military-medical education. In both groups, refractive correction was widespread (use of spectacles and/or contact lenses was reported by 87.3 % in the military-medical group and 87.8 % in the other group). However, experience of refractive laser surgery was more frequent in the military-medical group than in the other group, amounting to 15.1 % and 6.1 %, respectively ($p=0.002$).

Key words: refractive errors, military personnel, ophthalmic trauma, refractive laser surgery, first aid, military-medical education, state budget.

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РЕФРАКЦІЙНІ ПОРУШЕННЯ ТА ОФТАЛЬМОТРАВМА У ЗБРОЙНИХ СИЛАХ ЯК ФАКТОРИ ОБІЗНАНОСТІ ТА СОЦІАЛЬНО-ЕКОНОМІЧНИХ НАСЛІДКІВ

Метою дослідження було оцінити рівень обізнаності щодо порушень рефракції, офтальмологічних травм та їх корекції, навичок надання першої допомоги, а також знань, пов'язаних із підвищенням довгострокової ефективності рефракційних лазерних процедур, у контексті їхнього потенційного впливу на боєготовність збройних сил та державний бюджет у різних військових контингентах. Було проведено поперечне опитування з використанням анкет серед військовослужбовців віком 20–35 років, які проходять службу в різних військових структурах Азербайджану. Загалом у дослідженні взяли участь 450 респондентів (середній вік складав 25,4 років); з них 205 (45,6 %) належали до групи з військово-медичною освітою, а 245 (54,4 %) – до групи без військово-медичної освіти. В обох групах корекція рефракції була широко поширена (використання окулярів та/або контактних лінз зазначили 87,3 % у групі з військово-медичною освітою та 87,8 % в іншій групі). Однак досвід проведення рефракційної лазерної хірургії був більш поширеним у військово-медичній групі, ніж в іншій, і становив 15,1 % та 6,1 % відповідно ($p=0,002$).

Ключові слова: порушення рефракції, військовослужбовці, офтальмологічна травма, рефракційна лазерна хірургія, перша допомога, військово-медична освіта, державний бюджет.

In the context of modern armed conflicts and intensive tactical training, ocular injuries are regarded among military contingents as a priority problem from both medical and socio-economic perspectives. According to global estimates, in various regions, including conflict zones, severe forms of ophthalmic trauma are among the principal causes of visual disability and loss of working capacity [10].

Among military personnel, the loss of working days, prolongation of the rehabilitation period and reduced rates of return to duty create a substantial burden not only at the individual level but also in terms of the overall combat readiness of the armed forces and the expenditure of the state budget [13].

International studies indicate that, among military personnel, ocular injuries in certain conflicts account for 5–10 % of all combat-related wounds, and that in approximately one-third of these cases vision loss at the level of blindness occurs; such losses, in turn, are accompanied by complete or partial unfitness for service, as well as long-term compensation and social security obligations for the affected service member [4].

On the other hand, data on ophthalmic injuries occurring in industrial and workplace settings

indicate that, even in the civilian sector alone, the annual costs of such injuries amount to hundreds of millions of dollars, and extrapolation of this figure to military institutions provides grounds to assume a high economic efficiency of preventive interventions for the state budget [1].

Refractive errors – myopia, hypermetropia and astigmatism are highly prevalent in young age groups and play a decisive role in determining the fitness of conscription-age youth for military service [5]. In a number of countries, high myopia and other refractive anomalies are regarded as absolute contraindications for certain military specialties, and this indirectly results in economic losses in the form of lost potential military personnel, as well as a narrowing of the eligible contingent due to visual criteria [11].

In the last decade, refractive laser surgery (PRK, LASIK, SMILE, etc.) has been recognised as an approved intervention modality for military personnel, and in many armed forces thousands of service members have benefited from these procedures. Although long-term outcomes generally demonstrate satisfactory safety and keratometric stability, special clinical protocols that take into

account additional risks under traumatic conditions are considered necessary [6].

In the military context, the application of refractive surgery aims not only to improve individual visual comfort but also to eliminate the limitations associated with spectacles and contact lenses in combat conditions. However, to preserve the long-term effectiveness of refractive procedures, the prevention of ocular trauma, the use of ballistic protective eyewear and the acquisition of appropriate first-aid behaviours in cases of chemical and thermal injuries are of crucial importance, since inappropriate actions may lead both to vision loss and to additional treatment and rehabilitation costs for the state [1].

In the Azerbaijani context as well, during the 44-day Patriotic War and other military operations, ocular injuries and complications of refractive errors have been noted as a pressing problem. Local reports and publications emphasise the strategic importance of military ophthalmic care, including trauma prevention, timely correction of refractive errors and pre-planned refractive surgery, in terms of national security and the preservation of human capital.

In this context, the systematic assessment of the level of awareness regarding ophthalmic trauma and refractive surgery among different military contingents is an essential initial step for both clinical and macroeconomic decision-making.

The purpose of the study was to evaluate, across different military contingents, the level of awareness regarding refractive errors, ophthalmic trauma and their correction, refractive laser procedures and the appropriateness of first-aid behaviours in different trauma scenarios.

Materials and methods. Study design and target population. The study was conducted in the format of a cross-sectional questionnaire survey combining quantitative and analytical approaches. The target population comprised 20–35-year-old service members serving in various military structures of Azerbaijan (infantry, special forces, air and naval forces), as well as cadets and trainees of the Azerbaijan Higher Military School named after Heydar Aliyev and the Military Medicine Faculty of Azerbaijan Medical University. The study was conducted in the period of May 2023 to November 2025.

A total of 450 respondents were included in the study. Sampling was performed purposively, ensuring a balanced representation of service (those in the phase of active combat–military training activities) and education (future officers and military physicians) categories. The respondents were divided into two main groups:

– Military-medical education group – students and graduates of the Higher Military School and the Military Medicine Faculty (n=205; 45.6 %; mean age 25.9 years);

– Group without military-medical education – soldiers, sergeants and extended-service personnel

with general secondary or non-medical higher education, etc. (n=245; 54.4 %; mean age 25.02 years).

A structured questionnaire was developed to assess participants' demographic characteristics, vision correction habits, personal experience with ophthalmic trauma and level of knowledge. The questionnaire covered the following five sections:

1. Demographic indicators (age, sex, education and service status);

2. Personal experience related to ocular trauma (occurrence of trauma in oneself and/or a comrade, types of traumas);

3. Knowledge of first aid in cases of penetrating injury, blunt contusion, thermal burn, chemical burn, photochemical trauma and injuries caused by shrapnel/small particles;

4. Correction of refractive errors (spectacles, contact lenses, refractive surgery) and awareness of refractive laser interventions;

5. Post-refractive behavioural and preventive practices (use of artificial tear drops, restriction of physical activity, UV-protective spectacles, avoidance of sauna/bath, reduction of screen load, etc.).

For each trauma scenario, multiple-choice items were included that differentiated “should do” (correct, safe) and “should not do” (incorrect, risky) behaviours.

Data analysis was performed using SPSS software. For categorical variables, Group×Response cross-tabulations were constructed, and between-group differences were evaluated using Pearson's χ^2 test. For quantitative variables (age, etc.), Student's t-test was applied. The threshold for statistical significance of differences in proportions was set at $p<0.05$. In the Results section, indicators selected according to criteria of representativeness and clinical relevance are presented, while all cross-tabulations and χ^2 statistics are retained in the technical appendices.

Ethical and bioethical considerations and limitations. The study was conducted in accordance with the principles of the Declaration of Helsinki and generally accepted bioethical principles of respect for autonomy, confidentiality and non-maleficence. The university bioethics committee did not convene before the start of the study, and no protocol number was assigned, because the research had the format of an anonymous, non-interventional questionnaire survey and did not involve diagnostic or therapeutic procedures, experimental interventions, collection of biological material, access to medical records or processing of directly identifiable personal data. Participation was voluntary; verbal informed consent was obtained from all respondents before completion of the questionnaire, and participants were informed that refusal to participate would not affect their service, education or professional evaluation. The main ethical limitations of the study were the military

status of respondents, which could theoretically create a risk of perceived obligation to participate, and the use of self-reported data; these risks were minimized by anonymous data collection, absence of names or service identifiers in the database, aggregate statistical analysis only, and the possibility to decline any question or withdraw from the survey.

Results of the study. Of the 450 participants included in the survey, 205 (45.6 %) were officers and cadets with higher military and military-medical education, while 245 (54.4 %) were military personnel without specific medical training. The mean age was similar between the groups (25.9 and 25.02 years), which reduced the likelihood of age acting as a confounding factor.

In the military-medical group, 179 respondents (87.3 %) reported using spectacles and/or contact lenses, and 31 (15.1 %) indicated that they had undergone correction by means of laser refractive surgery. In the group without military-medical education, the corresponding figures were 215 (87.8 %) and 15 (6.1 %), respectively ($\chi^2=9.850$; $p=0.002$). This difference indicates that individuals with military-medical training adopt a more active stance in terms of assessing indications for refractive surgery and adherence to postoperative recommendations.

Cases of encountering ophthalmic trauma in oneself and/or a comrade amounted to 31 (15.1 %) in the military-medical group and 79 (32.2 %) in the other group. The spectrum of trauma differed significantly between the groups: in the military-medical group, blunt contusion-type injuries predominated (61.3 %), penetrating and thermal lesions accounted for a smaller proportion, and injuries to the ocular adnexa were not recorded. In contrast, in the group without military-medical education, injuries to the ocular adnexa were particularly frequent (59.5 %), which points to poor adherence to the use of protective eyewear.

In cases of penetrating injury, the military-medical group provided correct answers for all key items, removal of the casualty from the danger zone, stabilisation of the head, application of a soft sterile dressing to both eyes, use of a non-pressure protective shield over the eye and administration of analgesia – within a range of 92.7–100 % ($p<0.001$). In the group without military-medical education, by contrast, highly risky behaviours such as “attempting to remove the retained foreign body from the eye” and “applying pressure to the object in order to fix it” were selected by 91.0 % of respondents.

In blunt contusion trauma, the military-medical group demonstrated an almost flawless profile (93.7–100 % correct responses regarding not forcing open swollen eyelids, applying a non-pressure sterile dressing, immobilizing both eyes, elevating the head by 30–40°, using a cold compress and seeking urgent ophthalmic care), whereas in the group without military-medical education the proportion of correct

answers for these items remained within a range of 13.1–40.0 %, and the recommendation to elevate the head was not selected by any respondent ($p<0.001$).

In the thermal burn scenario, the military-medical group showed 88.8–100 % correct responses for items such as removing the casualty from the danger zone, not separating adherent eyelids, cooling the periocular area with a cloth soaked in cold water and urgent evacuation to an ophthalmologist. In the group without military-medical education, these indicators ranged from 9.8–49.8 %, while incorrect behaviours such as pouring cold water directly onto the eye and applying a pressure bandage over the eye were chosen by more than 50 % of respondents.

In chemical burns, the principles of continuous irrigation, thorough rinsing with the eyelids opened and removal of superficial chemical residues were well understood in the military-medical group (84.4–100 % correct responses), whereas in the group without military-medical education, preference was given to risky options such as the use of neutralizing solutions (87.8 % of respondents chose an incorrect option; $p<0.001$). These findings clearly illustrate the risk of increased visual disability and treatment costs in real-life events when first aid is delayed or carried out in an inappropriate manner.

In the photochemical trauma scenario, in the military-medical group, removal from the irradiation zone, calming and reassuring the casualty, use of artificial tear preparations, protective dark spectacles, temporary discontinuation of contact lens wear and the mandatory nature of ophthalmological examination were all endorsed at almost 100 % levels. In the group without military-medical education, by contrast, the proportion of correct answers for most of these items ranged from 13.1–63.7 %, and not a single respondent selected the item indicating the necessity of consulting an ophthalmologist.

For injuries caused by shrapnel and small particles, the military-medical group showed 94–100 % correct responses for items such as not touching or rubbing the eye, irrigating with solution in the case of minor superficial injuries and refraining from attempts to remove deeply embedded foreign bodies, whereas the group without military-medical education was characterized by a high rate of incorrect responses across all these items (in particular, attempts to remove foreign bodies in deep injuries) ($p<0.001$).

Awareness of refractive laser interventions in the military-medical group had predominantly been formed through military training courses: 146 individuals (71.2 %) reported becoming familiar with the topic within the framework of military courses, while 59 (28.8 %) indicated professional medical education as the source. In the group without military-medical education, 209 respondents (85.3 %) selected the answer “I have no information,” and only 14.7 % referred to general sources ($\chi^2=450$; $p<0.001$).

With regard to postoperative behavioural recommendations, in the military-medical group the items such as using eye drops in accordance with medical prescriptions, protection from trauma, temporary avoidance of sauna/bath, hygienic procedures, restriction of physical activity, reduction of screen load, use of UV-protective spectacles and performance of eye exercises were virtually accepted by 100 % of respondents. In the group without military-medical education, however, the proportion of incorrect answers was high, particularly for items concerning avoidance of sauna/bath, ocular hygiene and the use of UV-protective spectacles, and some recommendations were not recognised at all, with correct responses remaining within the 20–50 % range ($p < 0.001$).

Knowledge regarding the role of ocular trauma prevention during active service in maintaining the long-term effectiveness of refractive laser surgery was universal in the military-medical group (100 % “yes”), whereas in the group without military-medical education only 11.4 % acknowledged this link and 88.6 % chose the answer “no” ($\chi^2 = 350.674$; $p < 0.001$).

Within the military-medical group, some differences were observed between the subgroups with incomplete higher education (cadets and trainees; 80.0 %) and those with complete higher education (20.0 %). Personal exposure to trauma was higher in the incomplete higher education subgroup; however, appropriate first-aid behaviours in emergency situations were well mastered in both subgroups. Items such as continuous irrigation in chemical burns and non-pressure sterile dressing in thermal burns were endorsed at slightly higher rates in the complete higher education subgroup, which demonstrates the additional contribution of advanced professional training to the assimilation of more nuanced protocols. At the same time, military training courses remained the main source of information on laser refractive interventions for both subgroups.

Discussion. By comparatively demonstrating knowledge and behavioural profiles related to refractive errors, ocular trauma and refractive laser surgery across different military contingents, this study clearly highlights the potential benefits of military-medical education for military preparedness and the state budget. The high level of mastery of appropriate first-aid behaviours for virtually all trauma scenarios in the military-medical group is consistent with what has been reported in the international literature. Thus, timely and protocol-adherent provision of first aid can help prevent an increase in visual disability and the number of surgical interventions, as well as the prolongation of rehabilitation periods, thereby substantially reducing the associated social costs [12].

In the group without military-medical education, both the heavier trauma profile (particularly injuries to the ocular adnexa) and the high tendency toward incorrect behaviours indicate

the presence of gaps in practical training. Systematic use of protective eyewear, correct first-aid measures in cases of chemical and thermal trauma, and the adoption of artificial tear preparations, UV-protective spectacles and mandatory ophthalmological consultation in photochemical injuries as normative requirements may partially compensate for these gaps. The economic efficiency of such interventions is supported by cost analyses of ocular injuries in workplace and military populations, as a substantial proportion of the approximately 300 million dollars in annual expenditures could be reduced through preventive measures) [3].

The implementation of refractive laser surgery within large-scale military programmes has already been established as an evidence-based practice in the experience of the United States and other countries, with thousands of service members having benefited from this intervention, and long-term outcomes being assessed as satisfactory in terms of safety and effectiveness under conditions of active military service [2].

Furthermore, specific risks exist for eyes that have undergone refractive surgery in traumatic environments (for example, the risk of LASIK flap dislocation, retinal detachment, etc.), which further underscores the critical importance of knowledge and skills related to the prevention of ocular trauma in the postoperative period. Given that, in the Azerbaijani military context, the proportion of service members who have undergone refractive procedures is expected to gradually increase, the development of dedicated training modules for this group, the updating of clinical protocols and the strengthening of simulation-based training can be regarded as a long-term investment for the state [14]. This is also consistent with recent evidence showing that dry eye symptoms after refractive surgery in army recruits may affect training tolerance and therefore require early detection, preventive counselling and follow-up [7].

The findings of the study also reflect structural characteristics of the training ecosystem. Specifically, while respondents with military-medical education predominantly cited formal training and internet resources as their main sources of information, the group without military-medical education tended to rely more on incidental brochures and non-structured information channels. This highlights the importance of making module-based training packages on the prevention of refractive errors and ocular trauma – supported by digital platforms and grounded in visual educational materials – accessible to the broader military contingent [8, 9, 15]. Recent data from combat-related ocular trauma cohorts and systematic reviews additionally confirm that fragmentation injuries, blast mechanisms and delayed specialised care remain relevant determinants of visual outcomes, while structured prevention and early referral can reduce both medical and operational losses [9, 16].

Conclusions

1. The survey conducted among different military contingents showed that refractive errors are highly prevalent and, although the use of spectacles/contact lenses was high in both groups, personal experience with and knowledge of refractive laser procedures were predominantly concentrated among personnel with military-medical education.

2. Ophthalmic trauma events were observed with particularly higher frequency in the group without military-medical education; in this group, both the aggravation of the trauma spectrum (injuries of the ocular adnexa) and the predominance of inappropriate first-aid behaviours revealed serious gaps in trauma prevention.

3. While the mastery of correct first-aid protocols for penetrating, blunt, thermal and chemical trauma, photochemical injuries and injuries caused by shrapnel/small particles was practically universal in the military-medical group, the proportion of incorrect answers was high in the group without military-medical education, and these differences were statistically significant for all key indicators.

4. Knowledge regarding the prevention of ocular trauma during the period of active service, aimed at preserving the long-term effectiveness of refractive laser procedures, was universal only in the military-medical group, which indicates the necessity of developing targeted preventive programmes for service members who have undergone refractive surgery.

The findings demonstrate that the expansion of military-medical education, the tightening of regulatory requirements governing the use of ballistic protective eyewear, the timely correction of refractive errors and the development of curriculum-based training packages on refractive surgery represent a promising strategy not only for improving clinical outcomes but also for reducing the burden on the state budget.

Prospects for further research. Further studies should include larger multicenter military cohorts with prospective follow-up to assess whether structured ophthalmic trauma-prevention training, protective eyewear adherence and post-refractive-surgery counselling reduce ocular injury rates, visual disability, rehabilitation time and state-budget costs.

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