

**REPUBLIC OF AZERBAIJAN**

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**ABSTRACT**

of the dissertation for the degree of Doctor of Philosophy

**RISK FACTORS, PREVENTION AND TREATMENT OF EYE  
DISEASES IN RAILWAY WORKERS (IN THE EXAMPLE OF  
BAKU CITY)**

Specialty: 3212.01 – Health care and its organization

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## INTRODUCTION

**The actuality and processing degree of the subject.** Azerbaijan Railways and Metro play a major role in economy of the country: 2.8 million people in a year travel by railway, and more than 231 million people in a year use metro. The safety of these people depends on adequate provision of traffic of trains. Dozens of specialists of different professions provide the movement of trains. 6760 (2018) people work in the railway and 12623 (2018) in the metro of the country. Medical care for specialists providing movement of trains (SPMT) aims to protect the health of both railway workers and passengers. Therefore, the scientific substantiation of the railway health care system is a large-scale problem of state importance due to its socio-economic significance. There are many scientific research-works for solving this problem and they have been conducted for many years<sup>1;2;3;4</sup>. A significant share of these studies is focused on the early detection and prevention of professional diseases and other pathologies among railway workers, that complicate professional activity. Risk factors of working conditions of railway workers (noise, vibration, toxic substances, work regime, labor stress, etc.) and they co-occur at different levels and variants of different railway system- and cause professional diseases in various nosological forms (neurosensory hearing loss, vibration disease, musculoskeletal disorders,

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<sup>1</sup>Pradhan, G., Pattnaik A., Panda S., Panda B. Occupational Health challenges of railway Employees in India – Towards developing a Comprehensive Frame Work for Action // International journal of Emergency Mental Health and Human Resilience, 2015, vol.17, №2, - p 514-520

<sup>2</sup>European Agency for safety and Health at Work European risk observatory report. OSH in figures: occupational safety and health in the transport sector-An overview. Luxemburg. 2011, 260p.

<sup>3</sup>Laukzadeh Z., Zare Z., Mehrparvar A. et. al. Fitness-for-work assessment of train Drivers of Yazd Railway, Central Iran // Occupational and Environmental Medicine, 2013, vol.4. №3. 157-63.

<sup>4</sup>Kumah, D.B., Kuutiero, J.W., Merepf S.S. et. al. Ocular morbidity among auto mechanics at Suame-Magazine Area in the Kumati Metropolis // Mathews Journal of ophthalmology, 2017, 2(1):014

peripheral nerve damage, dust bronchitis, etc.).<sup>5;6</sup> Majority of risk factors and inadequacy of preventive measures causes professional diseases of the eyes.<sup>7</sup> Professional diseases of eyes develop under the influence of physical, chemical and infectious factors of working conditions. The functional stress of the visual organ also causes professional disease. The risk of professional diseases in workers is also increased because of ametropia, heterophoria, myopia, hyperopia and other refractive and accommodation disorders.<sup>8</sup>

Working conditions of railway workers and work intensity significantly increases the risk of mental disorders, cardiovascular diseases and pathologies of the visual organ among them.<sup>9;10;5</sup>

Azerbaijani scientists have conducted a number of scientific studies over the past 10 years, taking into account social significance of health condition of railway workers and the possibility of implementation of prevention depending on the specific situation.<sup>11;12;13</sup>

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<sup>5</sup>Мологная, Е.В., Гулимова, В.А. Структура профессиональных заболеваний на дальневосточной железной дороге. // Общественное здоровье и здравоохранение, - 2015. №4, - с.84-87.

<sup>6</sup>Smith A.P., Smith Y.N. Effects of noise on the well-being of railway staff // JCBEN, 2017, 18-22 June, 1-11

<sup>7</sup>Бабанов, С.А. Профессиональные заболевания органа зрения, связанные с воздействием физических факторов // РМЖ “Клиническая офтальмология”, 2015. №2, - с.89-94.

<sup>8</sup>Леонова, Е.С. Концептуальные основы реформирования офтальмологической помощи и разработка организационной модели системы охраны зрения работников ОАО «Российские железные дороги»: / автореферат диссер. доктора мед.наук./ - Москва, 2012. - 50 с.

<sup>9</sup>Urhonen T., Lie A., Aamodt G. Associations between long commutes and subjective health complaints among railway workers in Norway // Preventive Medicine Reports, 2016, 4, 490-495.

<sup>10</sup>Lie, A., Skogstad M., Johannessen H. et.al. Occupational noise exposure and hearing: a systematic review // Int.Arch. Occup. Environ Health, 2016, 89:351-372.

<sup>11</sup> Bağırova, R.X. Dəmiryolçular arasında nevroloji yardıma tələbatı zəruriləşdirən xəstəliklərin yayılması // Azərbaycan tibb Jurnalı. Bakı.2012, №4, s. 74-77

<sup>12</sup>Həsənov, H.Ş. Ağayeva, K.F. Lokomotiv maşinisti və maşinist köməkçilərinin psixofizioloji səciyyələri // Azərbaycan Tibb Jurnalı, Bakı, 2012, №3. s. 117-120

Bagirova R.Kh. substantiated the features of the organization of neurological care in the institutional health system on the example of railway health care system.<sup>12;14</sup> Hasanova H. Sh. showed the ways of optimizing of medical care for railway workers by assessment of their health status.<sup>15;16</sup> Studying diseases of railway workers, loss of working ability, characteristics of mortality, Rzayeva A.J. developed a scientific basis for optimizing of medical care for them. These studies have not studied the characteristics of the function of visual organs of railway workers.<sup>17;18</sup> But studying in the practice of other countries it became clear that eye diseases are the third most common disease among railway workers, the second most common among machinists, and the first most common among dispatchers<sup>19;20</sup>. More than 10% of nasologic reasons of professional disability of railway

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<sup>13</sup> Рзаева, А.Д. О специфике смертности работников транспорта Азербайджана // Проблемы социальной гигиены, здравоохранения и истории медицины, Москва, 2013, №6, - с.35-37

<sup>14</sup> Bağırova, R.X., Dəmiryolçuların nevroloji yardımına tələbatının həcminin əsaslandırılması // Sağlamlıq, Bakı, 2012, №5, - s.141-14

<sup>15</sup> Гасанов, Г. Ш., Агаев, Ф.Б., Багирова, Р.Х. Эффективность реабилитационных мер у работников железнодорожного транспорта // -Казань: Общественное здоровье и здравоохранение. 2012, №4, - с. 39-41

<sup>16</sup> Həsənov H.Ş. Dəmiryolçularının sağlamlıq vəziyyətinin qatarların hərəkətini təmin edən peşələr üzrə, yaş və əmək fəaliyyətinin müddətindən asılı xüsusiyyətləri // - Bakı: Azərbaycan Tibb Jurnalı, 2012, №2. - s. 137-141

<sup>17</sup> Рзаева А.Д. О специфике смертности работников транспорта Азербайджана // Проблемы социальной гигиены, здравоохранения и истории медицины, Москва, 2013, №6, - с.35-37

<sup>18</sup> Рзаева А.Д. Общая заболеваемость по обращаемости железнодорожников различных профессиональных группах // Azərbaycan təbabətinin müasir nailiyyətləri, Bakı, №4, 2013, - s.165-169.

<sup>19</sup> Леонова, Е.С. Результаты углубленного клинико-физиологического обследования органа зрения машинистов локомотивов / Е.С.Леонова, И.Н.Бянкина, Е.В.Щекотов [и др.] // - М.: Медицина труда и промышленная экология, - 2011. № 1, - с. 38-42.

<sup>20</sup> Леонова, Е.С. Экономический эффект лечебно-профилактических мероприятий у машинистов локомотивов с функциональными нарушениями зрительного анализатора // - М.: Проблемы управления здравоохранением, - 2011. № 1(56)11, - с.80-85.

workers are connected with eye diseases. There was conducted no scientific research works on dependence of prevalence of eye diseases in the Azerbaijan Railways System on professional spheres and labor activity, also risk factors. According to the above mentioned factors it is considered that the subject of the planned and conducted study is relevant.

**The subject and object of the study:** Employees providing train traffic in the railway system of the Republic of Azerbaijan are object of the study and the condition of visual functions of SPMTs and vision disorders are subjects of the study.

**The purpose of the study:** To substantiate the role of eye diseases in the health status of railway workers, the priorities and opportunities of their prevention.

**Objectives of the study:**

- To assess the rate of primary and general morbidity of railway workers with eye pathologies, loss of working ability and the volume of ophthalmological problems;
- To investigate the reasons of professional disability caused by health status of railway workers and to determine the role of eye diseases in their formation;
- To determine the state of visual function and the prevalence of eye diseases on the basis of complex ophthalmological examination of railway workers;
- To detect the prevalence features of eye diseases in professional groups of railway workers;
- To create a basis for optimizing of ophthalmological care for railway workers.

**Methods of the study:**

- Methods of studying primary and general morbidity reasons, temporary disability;
- The method for studying the prevalence of diseases;
- The method of expert assessment based on norms;
- Ophthalmological examination methods (biomicroscopy, ophthalmoscopy, refraction, determination of color and intra-ocular vision, Schirmer test, etc.)

- Statistical methods (calculation of intensive quantities, standard error, determination of reliability interval,  $\chi^2$ ).

**The main provisions of the dissertation to be defended:**

- The morbidity rate of railway worker with eye pathologies is high, their timely detection reduces the risk of occupational disability
- Referrals to ophthalmologists are at a satisfactory level, but do not fully reflect the real need and it is necessary to conduct adequate comprehensive preventive examinations;
- The risk of eye diseases among railway workers depends on age, employment duration, working sphere and professional activity, their initial prevention should be organized based on these factors.

**Scientific novelty of the study:**

- The morbidity rate of eye pathologies, the regularity of changes in the nosological structure depending on age and employment duration were revealed in Bilajari locomotive and wagon depot, railway communication and power supply group, and among those working in the steam washing station;
- In condition of availability of ophthalmological care the common and different aspects of the overall morbidity and prevalence of eye pathologies have been identified on example of railway workers;
- A long-term trend of professional incompetence of railway workers has been identified, the role of different nosological forms in its formation has been determined;
- The prevalence rate of eye disease among railway workers depending on their age, employment duration, field of activity and type of profession and different aspects of the nasal structure have been identified.

**Theoretical importance of achieved results of the study.** The results of the study are enriched with new provisions of the concept of the formation of pathologies and functional status of the visual organ under the combined influence of endogenous (individual age)

and exogenous (working conditions, professional activity, work experience).

**Practical importance of achieved results.**The results of the study are significant as a predictor for the prevention and early treatment of eye diseases of employees engaged in labor activities that cause visual disturbances. These results let to create an opportunity to plan sanitary education with railway workers. Volume of scientifically substantiated work of an ophthalmologist helps to create conditions for substantiation of staff norms in accordance with the existing needs. It is possible to plan their individual observation based on the condition of the visual organ during the recruitment of railway workers.

Approbation and application of the dissertation. Separate fragment of the dissertation work "Modern medicine: new approaches and actual studies") have been reported in the XXXIV international scientific-practical conference (April 2020, Moscow), international scientific-practical conference dedicated to the 90th anniversary of Azerbaijan Medical University (the Azerbaijan Medical University, Baku 2020), in the scientific-practical conference dedicated to the birthday of Aziz Aliyev, discussed at the scientific council of the Azerbaijan State Advanced Training Institute named after A. Aliyev. Initial discussion of the dissertation work was conducted at the interdepartment meeting (Department of Health Organization and Management with a course in pedagogy, psychology and foreign languages, Ophthalmology, Central Scientific Research Laboratory - CSRL) in the Azerbaijan State Advanced Training Institute named after A. Aliyev (protocol №5; April 6, 2022). The results have been reported and discussed at the scientific workshop of the dissertation council ED 1.03 under the National Center of Ophthalmology named after academician Z. Aliyeva (June 30, 2022; protocol №20).

The recommendations for the dissertation work are applied in polyclinic No. 1 of Baku Railways LLC and No. 2 of Baku Railways LLC. The results obtained in the dissertation are used as evidence data in the education of medical specialists and residents in the field of "Organization of health care".

**Name of the organization where the dissertation work was conducted:** The Azerbaijan State Advanced Training Institute named after A.Aliyev.

**The total volume of the dissertation with symbols, indicating the volume of the structural units of the dissertation separately:** The volume of the dissertation consists of Introduction – 8523 symbols; Chapter I Literature Review – 41801 symbols; Chapter II Materials and Methods of the Study – 11125 symbols; Achieved Results (Chapter III– 43357 symbols; Chapter IV– 15655 symbols; Chapter V – 22967 symbols; Chapter VI– 21105 symbols;) Chapter VII (discussion and conclusion of the achieved results) – 23275 symbols; Conclusion – 1953 symbols; Practical Recommendations – 1079 symbols. 18 Azerbaijan, 89 Russian and 86 English sources were used in the list of literature.

The volume of the dissertation by symbols is (without tables, graphs and bibliography) – 190840, consists of 37 tables, 13 diagrams and 1 scheme.

## **MATERIALS AND METHODS OF THE STUDY**

Research materials have selected in correspondence with the goals and objectives of the study.

As the railway workers, which provide the movement of trains, operate in hard, harmful working conditions accurate information on their quantity is compiled annually by the personnel department at the request of the Center for Hygiene and Epidemiology and presented to the polyclinic. According to this document, in 2019, when we began to observe the Bilajari railwaystation there were 2277 employees directly providing the movement of trains, 1200 of them work at locomotive depot, 336 - Bilajari wagon depot, 320 – at Bilajari railway power supply group, 136 – at Bilajari washing evaporator (at the steam washing station), 285 – at Bilajari railway communication group.

Outpatient cards of locomotive depot employees providing train traffic on Bilajari railway station (form 25) have been investigated and clarified (final): the quantity of ophthalmological diagnoses is 424, 271 of them are reflex anomalies (myopia,

hyperopia, astigmatism), 72 – are conjunctivitis, 18 - cataracts, 22 - retinal pathologies, 4 - consequences of previous traumas, 37 - other diseases. Diagnosis in 193 of these diseases (95 refractive anomalies, 65 conjunctivitis, 7 cataracts, 6 retinal diseases, 2 trauma consequences, 18 other pathologies) were registered with a (+).

Information on eye diseases bulletins and lost days have been collected as observation documents.

The professional suitability of railway workers is assessed by the Medical Expert Commission based on the results of a medical examination and properly documented. Three options of decision are accepted by Medical Expert Commission: valid; temporary invalid; invalid.

The decisions of the Medical Expert Commission were analyzed according to the results of the medical examination of the railway workers, who provide the movement of trains.

For obtaining of comprehensive information on the ophthalmological health of the railway workers, who provide the movement of trains, he have conducted their ophthalmological examination. In the process of examination we have detected 575 eye disease (including new diseases not reflected in 151 applications), 365 of which are refraction anomalies (94 new cases), 18 chronic conjunctivitis, 57 cataracts (39 new cases), 70 retinal diseases (48 new cases), 9 trauma consequences, 56 other eye diseases (19 new cases).

Minimum volume of preventive ophthalmological examination:

- Assessment of complaints and medical history;
- External view of the eyeball;
- Biomicroscopy of the anterior part of the eyeball;
- Ophthalmic biomicroscopy with high diopter lenses;
- Determination of visual acuity with and without correction;
- Examination of refraction, color and binocular vision;
- Definition of field of vision;
- Tonometry;
- Determination of twilight visual acuity and sensitivity
- Screen test.

Information which we have obtained are quality signs according to their character.

### **INITIAL AND GENERAL MORBIDITY OF EYE PATHOLOGIES AMONG RAILWAY WORKERS, LOSS OF WORKING ABILITY AND THE VOLUME OF APPLICATIONS**

Initial morbidity rate of eye pathologies (pathology for the first time in his life) is  $16.1 \pm 1.1$  in the locomotive depot;  $14.3 \pm 1.9$  in the wagon depot;  $41.9 \pm 4.2$  at the steam washing station;  $17.9 \pm 2.3$  in the communication group and  $18.4 \pm 2.1$  in the electrical equipment groupper 100 persons. Difference in areas compared due to the general morbidity rate ( $35.3 \pm 1.4$  locomotive depots per 100 people;  $22.6 \pm 2.3$  in the wagon depot;  $57.4 \pm 4.2$  at the steam washing station;  $38.9 \pm 2.8$  in the communication group and  $36.6 \pm 2.7$  in the electrical equipment group) is deeper, very low in the car depot, very high in the steam washing station and moderate in other areas.

The nosological structure of initial and general morbidity cases is changeable (49.2 and 63.9% refractive anomalies, 33.6 and 17.0% conjunctivitis in the locomotive depot, 70.8 and 77.6% refractive anomalies, 16.6 and 10.3% conjunctivitis in the car depot, 50.8 and 50.0% refractive anomalies, 31.6 and 24.4% conjunctivitis in the steam washing station, 68.6 and 76.6% refractive anomalies, 15.7 and 8.1% conjunctivitis in the communication group, 71.2 and 79, 5% refractive anomalies, 18.6 and 10.2% conjunctivitis in the power supply group), The share of conjunctivitis in the locomotive depot and steam washing station is relatively high, the specific gravity of refractive anomalies is high in the power supply group and wagon depot.

The initial and general morbidity rate in all professional spheres of railway workers providing movement of trains increases proportionally depending on age and length of service.

Temporary lost of working ability because of eye diseases ( $4.0 \pm 0.5$  in the locomotive depot per 100 people;  $5.7 \pm 1.2$  in the wagon depot; and  $6.6 \pm 1.3$  in the electrical equipment group;  $30.1 \pm 3.9$  at the steam washing station;  $11.6 \pm 1.9$  in the communication group) is

relatively high at the steam washing station, and medium in the communication group and low in other areas, dependence on age and work experience statistically increase only at the steam washing station and in the communication group.

The quantity of application to doctor ophthalmologist for diagnosis and treatment per 100 persons changes depending on age ( $15.7 \pm 4.3$  -  $60.8 \pm 2.2$  in locomotive depot workers aged  $<30$  and  $>50$ ;  $50.9 \pm 11.1$  -  $45.6 \pm 4.9$  in wagon depot employees;  $40 \pm 8.9$  -  $80 \pm 4.4$  in the power supply group;  $61.1 \pm 11.1$  -  $97.1 \pm 2.8$  at the steam washing station;  $58.3 \pm 10.1$  -  $87.6 \pm 3.4$  in the communication group), work experience (work experience  $<5, 5-10$  and  $>10$  years  $28,3 \pm 2,0$  -  $60,8 \pm 2,2$  in locomotive depot,  $54,9 \pm 5,4$  -  $63,3 \pm 4,7$  in wagon depot,  $46,5 \pm 5,3$  -  $63,2 \pm 5,1$  in the power supply group,  $71,7 \pm 6,1$  -  $110$  in the steam washing station,  $53,1 \pm 5,6$  -  $90,9 \pm 3,3$  in the communication group), working areas (most in steam washing station and relatively few in locomotive depots, among employees older than 40 years, in wagon depots among employees older than 50 years).

### **REASONS OF PROFESSIONAL DISABILITY AMONG RAILWAY WORKERS, PROVIDING TRAINS MOVEMENT, RELATED TO HEALTH PROBLEMS**

$8,7 \pm 0,9\%$  of reasons of professional disability among railway workers occurred during 2009-2018 years was eye diseases and eye diseases are on the third place among reasons of professional disabilities.

Professional disability of railway workers providing train traffic due to eye diseases is mainly was formed due to refractive and color vision abnormalities ( $35,8 \pm 5,3$  and  $27,2 \pm 4,9\%$ ), relatively rarely - crystalline diseases ( $18,5 \pm 4,3\%$ ) and glaucoma ( $14,8 \pm 3,9\%$ ).

Professional disability related to eye diseases relatively many have been recorded among railway workers serving during travel ( $23,2\%$ ), station-shunting group ( $19,8\%$ ) and locomotive drivers and their assistants ( $18,8\%$ ), and in relatively rare cases among dispatcher-operator ( $8,1\%$ ), in power supply and communication groups ( $6,5\%$ ).

The quantity of professional disabilities decreased in 1999-2008 and 2009-2018 years (94 and 81, respectively). The distribution of dismissals varies due to age (share of 50 and older increases, share of those <40 years old decreases), length of service (share of those with more than 20 years of experience increases, share of those with <5 years of experience decreases), occupation (share of locomotive drivers and assistants) (the share of workers in other professions decreases) and the nosological structure of eye diseases (the share of refractive anomalies decreases; the share of crystalline diseases and glaucoma increases).

Regardless of nosological reasons professional disabilities of railway workers appears among employees older than 50 years and after 20 years of working experience.

The frequency of professional disability of railway workers providing the movement of trains changes within the interval of 0.6-1.5%, the indicators of locomotive and wagon depot employees ( $13.3 \pm 0.3$  and  $0.9 \pm 0.5\%$ ), power supply group and communication workers ( $0.9 \pm 0.5$  and  $0.7 \pm 0.5\%$ , respectively) close to each other depends on working experience (<5.5-10,> 10 years of work experience  $0.2 \pm 0.2$ ;  $0.8 \pm 0.3$  and  $1.9 \pm 0.5\%$ , respectively).

### **STATUS OF VISION FUNCTION OF RAILWAY WORKERS PROVIDING THE MOVEMENT OF TRAINS AND MORBIDITY RATE OF EYE DISEASES AMONG THEM (RESULTS OF COMPLEX PREVENTIVE EXAMINATIONS)**

$47.0 \pm 1.0$  eye diseases are recorded per 100 railway workers providing the movement of trains, the morbidity rate of eye diseases depends on from the field of activity of employees ( $39.3 \pm 2.6$  in the car depot,  $45.7 \pm 2.7$  in the power supply group,  $46.7 \pm 2.9$  in the group of communication workers,  $47.9 \pm 1.4$  in the locomotive depot and  $62.5 \pm 4.1$  at the steam washing station), age ( $20.4 \pm 3.1$  years <30;  $34.5 \pm 2.4$  years 30-39;  $44.2 \pm 1.6$  years 40-49;  $61.6 \pm 1.3$  At age 7> 50) and length of service ( $27.1 \pm 2.0$  years of service <5 years;  $46.1 \pm 1.5$  years of service 5-10 years;  $60.5 \pm 1.7$  years of service > 10 years).

The presence of eye diseases during the recruitment of railway workers is one of the counter-factors that increases the risk of other eye diseases during their employment. It is approved on the example of the machinist and machinist assistants that the persons with and without eye pathology at the time of employment have different levels of eye disease in the range of 30-39 years and 5-10 years of service ( $22.7\pm 6.3$  and  $43.8\pm 8.7$  diseases per 100 people) 40-49 years 5-10 years ( $35.6\pm 4.7$  and  $57.1\pm 6.6$ ) and > 10 years of work experience ( $41.8\pm 5.0$  and  $72.9\pm 6.4$ ), after 50 years of work experience > 10 years ( $46.1\pm 4.6$  and  $78.9\pm 4.6$ ).

Refractive anomalies occupy the first place among the eye diseases of railway workers, the frequency of these pathologies (per 100 persons) and its share among all eye diseases (totally %) was  $30.8 \pm 1.3$  and 63.5% in the locomotive depot;  $23.2\pm 2.3$  and 59.1% in the wagon depot;  $31.9\pm 2.6$  and 70.3% in the power supply group;  $35.3 \pm 4.1$  and 56.5% at the steam washing station;  $31.9\pm 2.7$  and 68.4% of communication group employees. There is an excessive risk of conjunctivitis at the steam washing station.

The number of persons with visual acuity  $>0.9$   $37.5\pm 4.1\%$  (steam washing station)  $-78.6\pm 2.2\%$  (in the car depot); the share of those with 0.4-0.6 % visual acuity varied in the range between  $1.5\pm 0.5\%$  (wagon depot) -  $22.1\pm 3.5\%$  (at the steam washing station) depending on working spheres of railway workers providing movement of trains. Normal tear flow in this category of railway workers was  $68.0\pm 4.6\%$  in the locomotive depot,  $65\pm 4.7\%$  in the wagon depot,  $50\pm 5.0\%$  in the power supply group and  $34\pm 4.7\%$  in the steam washing station. Violation of moderate and severe tear flow was  $5\pm 2.1\%$  in locomotive depot workers,  $7\pm 2.5\%$  in wagon depot,  $17\pm 3.7\%$  in power supply group,  $21\pm 4.1\%$  in communication group and  $24\pm 4.2\%$  in steam washing station.

### **PREVALENCE OF EYE DISEASES IN PROFESSIONAL GROUPS OF RAILWAY WORKERS PROVIDING MOVEMENT OF TRAINS**

The quantity of eye diseases in groups of machinists and machinist assistants, locksmiths, technicians, operators, electricians, du-

ty officers, electromechanics, washers with different professional functions and passengers ranges from  $30.5\pm 4.4$  to  $58.3\pm 4.5$  per 100 persons, the morbidity rate among operators is high, among duty officers is low, and among other employees (machinist and assistant machinists, locksmiths, technicians, electricians, electromechanics, washers and passengers) is moderate ( $38.8\pm 4.2$  -  $48.5\pm 5.0$ ).

Refractive anomalies occupy the 1<sup>st</sup> place among eye diseases of all professional groups of railway workers, however, the specific share (36.7-76.1%) and frequency ( $14.8\pm 3.4$  -  $43.5\pm 4.6$  per 100 people) of these pathologies vary widely. Refractive anomalies are more common in operators, technicians and mechanics ( $35.7\pm 4.8$ - $43.5\pm 4.6$  per 100 people), less common in duty officers, washers and locksmiths ( $14.8\pm 3.4$  -  $17.2\pm 4.0$  diseases per 100 people), others were moderate ( $20.2\pm 3.5$  -  $29.4\pm 4.9$  diseases per 100 people). Statistically significant differences in professional groups are also confirmed by the frequency of conjunctivitis ( $1.0\pm 1.0$  -  $10.1\pm 2.8\%$ ). Conjunctivitis is more common in people who work at the steam washing station.

The professional groups of railway workers with work experience more by 10 years are not statistically significantly different due to with the exception of operators due to the frequency of eye disease and varies from  $9.1\pm 6.1$  to  $23.1\pm 11.6$  (per 100 persons), the morbidity rate in operators ( $33.3\pm 8.6$  cases per 100 people) is statistically higher than in technicians alone ( $9.1\pm 6.1$  cases per 100 people). The difference of morbidity rates between professional groups deepening on increasing working experience:  $9.1\pm 6.1$  -  $33.3\pm 8.6$  years work experience < 10 years,  $26.2\pm 6.7$  -  $59.4\pm 8.6$  years work experience 10-20 years  $43.9\pm 7.7$  -  $71.7\pm 6.1$  years of work experience > 20 years (per 100 people).

The morbidity rate of eye diseases among railway workers with work experience 10-20 years at age <45 and >45 per 100 persons was  $31.6\pm 5.3$  -  $56.1\pm 2.7$  (relative risk 1.77) in machinists and their assistants,  $30.0\pm 10.2$  -  $63.6\pm 10.2$  (relative risk 2.12) in locksmiths , technicians  $44.4\pm 11.7$  -  $62.5\pm 12.1$  (relative risk 1.41), operators  $57.1\pm 10.7$  -  $63.6\pm 14.5$  (relative risk 1.11), electricians  $42.8\pm 13.2$  -  $53.8\pm 13.8$  (relative risk 1.26),  $18.1\pm 8.2$  -  $35.0\pm 10.6$  (relative risk 1.93) on duty, 42 on electromechanics,  $1.0\pm 11.3$  -  $47.6\pm 10.8$  (relative risk

1.13), in washers  $33.3 \pm 10.2 - 43.5 \pm 10.3$  (relative risk 1.31) and in the passenger group 30.4 in the range of  $\pm 9.5 - 37.0 \pm 9.2$  (relative risk 1.22).

The morbidity rate of eye diseases in railway workers aged <45 years with work experience <10, 10-20 and >20 years increased for 2.25 times in locksmiths, 5.0 times in technicians, 2.1 times in operators, 2.9 times in electricians, 3.6 times in duty, 1.8 times in electro-mechanics, 5.6 times in washers, 4.1 times in the passenger group.

Relative risk of eye diseases increases depending on age and work experience of employees, although the role of both factors arises from a joint effect, the priority role of working conditions is evidenced by the level of relative risk.

The specific share of those with >0.9 visual acuity in the professional groups of railway workers is  $77.4 \pm 1.6\%$  of machinists and their assistants, and  $49.0 \pm 5.0\%$  - other professional groups. Visual acuity was <0.6 in few part of machinists and machinist assistants ( $1.9 \pm 0.5\%$ ), but the visual acuity was <0.6 in  $\leq 18.2 \pm 3.8\% - \geq 10.9 \pm 2.6\%$  of employees in other professional groups. Normal flow of tears was observed in  $89.3 \pm 1.1\%$  of machinist and machinist assistants, and in  $54.0 \pm 5.3 - 65.9 \pm 5.1\%$  of members of other professional groups. Distribution of professional groups of railway workers due to visual acuity and Shirmer test results depends on age and work experience.

## **DISCUSSION OF ACHIEVED RESULTS AND RATIONALIZATION OF THE OPTIMAL MODEL OF OPHTHALMOLOGICAL CARE**

Professional disability related to eye diseases is determined due to a decrease in visual acuity and color vision anomalies. It was determined that the refractive anomalies occupied first place among reasons of professional disabilities related to eye diseases during the last 20 years ( $51.1 \pm 5.2\%$  1999-2008 and  $35.8 \pm 5.3\%$ , in average 44%). The second main reason is color vision anomaly ( $25.6 \pm 4.9\%$  in 1999-2008 and  $27.2 \pm 4.9\%$  in 2009-2018 years; average indicator 26.3%). Next places on the list are occupied by crystal diseases ( $10.6 \pm 3.2$  and  $18.5 \pm 4.3\%$ , 14.3%, respectively), glaucoma ( $8.5 \pm 3.9$  and

14.8±3.9%; 11.4%) and other diseases (4.2±2.1 and 3.7±2.2%; 4.0%). The share of reasons of professional disabilities in the South Ural Railway respectively was as the following: 40.3% refractive anomalies, 22.1% crystalline diseases; 10.7% color vision abnormalities and 8.1% glaucoma. As it is seen there are different aspects in addition to the similarity of reasons of professional disabilities in the Bilajari and South Ural railways (Refractive anomalies on the 1st place): the share of color vision abnormalities in Bilajari is 26.3%, in South Ural is 10.7%. There is difference also due to crystal pathologies (14.3 and 22.1%). Similarity in the dynamics of the specific share of the causes of professional disabilities of railway workers is manifested by increasing in the proportion of crystalline diseases and decreasing of the proportion of refractive anomalies. Thus, eye diseases play serious role in formation of professional disabilities among professional disabilities of railway workers. The share of eye diseases among reasons of professional disabilities of railway workers is 8.7% in Bilajari and 5-11.2% in Russia. The similarity in this example is also noteworthy. We deeply studied the professional disabilities of railway workers and substantiated thesis that attract attention:

- Professional disability is most often recorded in railway workers aged 40 and over who have been working for more than 15 years;
- The risk of professional disability is often observed among machinist and machinist assistants, electromechanics, dispatchers and electro-gas welders;
- Refraction and color vision abnormalities, crystalline diseases and glaucoma associated with comorbidity (2 and more eye diseases) increases the risk of professional disability;
- Internal diseases, diseases of the nervous system, diseases of the ear and esophagus causes professional disabilities in persons older than 50 years, but eye diseases – in 40-49 years old persons;
- Professional disability is mainly found in periodic preventive examinations of railway workers. During periodic inspections at the locomotive depot signs of professional disability were registered in 1.3±0.3% of cases, in 0.9±0.5% of cases in the wagon

depot and power supply group, in  $0.7 \pm 0.55\%$  of cases in the communication group. A sign of professional disability was registered in preventive examinations among railway workers with work experience  $<5$ ,  $5-10$  and  $>10$  years correspondingly in  $0.2 \pm 0.2$ ;  $0.8 \pm 0.3$  and  $1.9 \pm 0.5\%$  of cases.

It was detected that the initial morbidity rate per 100 railway workers is  $16.1 \pm 1.1$  in the locomotive depot;  $14.3 \pm 1.9$  in the wagon depot;  $41.9 \pm 4.2$  at the steam washing station;  $17.9 \pm 2.3$  in the communication group and  $18.4 \pm 2.1$  in the power supply group. The initial morbidity rate in most cases is not significantly accurately different, only at the steam washing plant the initial morbidity rate is statistically high. As a whole the initial morbidity rate of railway workers providing moving of trains is high. This proves that the appeals of the railway workers are satisfactory against the background of the availability of ophthalmological care.

The general level of eye diseases according to the application data in the areas which we have observed is:  $35.3 \pm 1.4$  in the locomotive depot,  $22.6 \pm 2.3$  in the car depot,  $57.4 \pm 4.2$  in the steam washing station,  $38.9 \pm 2.8$  in the communication group and  $36.6 \pm 2.7$  in the power supply group per 100 persons. Difference between groups due to general morbidity rate is statistically correct. The morbidity rate is relatively low in locomotive depot, and is significantly higher at the steam washing station.

When the outpatient care is available such referral data do not fully characterize the disease. The preventive examinations have been used for obtaining more reliable data. The frequency of eye diseases 100 per persons, detected while preventive examination within the frames of our study is:  $47.9 \pm 1.4$  in locomotive depot,  $39.3 \pm 2.6$  in the car depot,  $45.3 \pm 2.7$  in the power supply group,  $62.5 \pm 4.1$  in the steam washing station and  $46.7 \pm 2.9$  in the communication group ( $47.0 \pm 1.0$  in total). In this example, the difference between groups and accuracy is noticeable: the number of diseases is relatively small in the wagon depot and relatively high in the steam washing station.

The remarkable point in the achieved results is that the general morbidity rate of railway workers ( $22.6 \pm 2.3 - 57.4 \pm 4.2$  diseases per 100 railwaymen) from the morbidity rate found in prophylaxis

lactic examinations ( $39.3 \pm 2.6$  -  $62.5 \pm 4$  per 100 people, 1) does not sharply differ. It can be considered that applications on provision of railway workers with satisfactory ophthalmological care approach real demand. We have detected in our study the initial and general morbidity rate and prevalence risk factors (fields of work, length of service and age) of eye diseases. We showed that the relative risk rate of eye disease among railway workers depending on fields of work (the ratio of indicators in areas where the disease is more or less prevalent) was 1.6. In the study of Russian scientists, this ratio was 1.7.<sup>21</sup>

The effect of eye disease morbidity risk on work experience was proven in our study. You can see these data in literature on the subject of the dissertation work.

The prevalence rate of eye disease detected while preventive examination due to the work experience range within the interval  $22.8 \pm 3.1$  -  $60.4 \pm 2.2$  per 100 persons (relative risk 2.6) in the locomotive depot,  $28.0 \pm 4.9$  -  $51.5 \pm 4.9$  (relative risk 1.8) in the wagon depot,  $23.2 \pm 4.5$  -  $62.1 \pm 5.2$  (relative risk 2.7) in the power supply group,  $43.4 \pm 6.8$  -  $80 \pm 7.3$  (relative risk 1.8) in the steam washing station,  $29.1 \pm 5.1$  -  $63.6 \pm 5.4$  (relative risk 2.2) in the communication group.

Thus, the field of activity, work experience and age can be considered as the main factors that increase the risk of eye diseases in railway workers. Therefore, the protection of railway workers from the harmful effects of these factors should be the main direction of the health system.

The general aspect of the achieved results is as following: eye diseases are relatively rare in the guards (control group) and in machinists ( $43.5 \pm 1.8$  per 100 people), locksmiths ( $40.2 \pm 5.2$  per 100 people), technicians ( $46.9 \pm 5$ , 0 per 100 people), operators ( $58.3 \pm 4.5$  per 100 people), electricians ( $47.1 \pm 5.4$  per 100 people), electro-me-

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<sup>21</sup>Горынина, О.А. Анализ заболеваемости среди работников основных профессий Горьковской железной дороги // - Нижний Новгород: Сборник материалов научно-практической конференции «Информационные технологии в модернизации здравоохранения», - 2011. - с. 61-64.

chanics ( $48.5 \pm 5.0$  per 100 people), eye diseases in washers ( $45.0 \pm 4.7$  per 100 people) and in the road group ( $38.8 \pm 4.2$  per 100 people) are statistically significant compared to them. With the exception of duty and passenger groups, other professional groups do not differ statistically significantly in the frequency of eye diseases ( $p > 0.05$ ).

Frequency of eye diseases detected in machinists and machinist assistants (per 100 persons) is  $43.5 \pm 1.8$  in our research and  $47.2 \pm 2.2$  in research work of O.A.Gorinina. Common aspect of the compared data: in both observations, the frequency of eye diseases in machinists and machinist assistants was lower than in other railway professions. Relatively high morbidity rate of eye diseases was detected in group of operators both in our study and study of Russian scientists ( $58.3 \pm 4.5$  and  $92.3 \pm 2.3$  per 100 persons)<sup>21</sup>. As it is seen, the morbidity rate of eye diseases in group of operators is lower for 1.6 times.

Changing of morbidity rate of eye diseases in all observed professional groups depending on age and work experience has a lawful character. But increasing rates of morbidity in professional groups depending on age and work experience are different. The relative risk (ratio of the incidence of diseases in the group with work experience  $\geq 20$  years to the corresponding indicator in the group with work experience  $< 10$  years) of eye diseases depending on work experience was 3.9 times in machinists and machinist assistants; 4.0 times – in locksmiths; 6.8 times – in technicians; 2.2 times – in operators; 2.8 times – in electricians; 2.7 times – in personnel on duty; 2.5 times – in electro-mechanics; 5.6 times – in washers; 3.0 times – in the road group.

As can be seen, the intensity of preventive examinations and the scope of the examination program should be stronger in the second 10 years of work experience of machinists, machinist assistants, locksmiths, technicians, operators, electricians and duty officers.

As the labour activity of railway workers is associated with visual tension, in most cases, their visual acuity is impaired. Therefore, monitoring of visual acuity is necessary. Decreased visual acuity is the main criterion of professional incompetence of railway workers. We have presented and assessed in our study the visual acuity of railway workers depending on their age and work experience by

areas of activity (locomotive depot, wagon depot, power supply group, communication group and steam washing station) and professional groups (machinist and machinist assistants, locksmith, technician, operator, electrician, electro-mechanic, duty officer, washer, road group). There is information in the literature about the visual acuity of a group of railway workers. Although this information is not entirely useful for comparison it is possible to come to some conclusions. Visual acuity of employees of the locomotive brigade on the Russian railway was 1.0 in the right and left eye and in 80.9 and 90.5% of cases; 0.9 and 9.5 in 9.6 and 9.5% of cases, respectively and 0.80% of cases. In our observation, the visual acuity of  $77.4 \pm 1.6\%$  of machinists and machinist assistants was  $>0.9$ ; visual acuity of  $90.7 \pm 1.5\%$  was 0.6-0.9 and visual acuity of  $1.9 \pm 0.5\%$  was 0.3-0.6 (in eye with poor eyesight). The visual acuity of locomotive depot workers in the right and left eye was  $>0.9$  respectively in  $74 \pm 1.2$  and  $75 \pm 1.2\%$  cases, 0.7-0.9 were recorded in  $24 \pm 1.2$  and  $22.9 \pm 1.2\%$  of cases (without correction). Although the subjects examined within the frames of our study are not the same as those examined by Russian scientists, it is clear that the frequency of cases of visual acuity  $>0.9$  (80.9 and  $77.4 \pm 1.6\%$ ) are close to each other.

Visual acuity in the operator group examined by Russian scientists was 1.0 in 62.2-69.0% of cases; 0.9 in 6.9-13.9% of cases; 0.8 in 3.4% of cases; 0.7 in 3.4% of cases; 0.6 in 6.9% of cases; 0.5 in 10.4% of cases; 0.4 in 3.4-6.9% of cases. In our observation, there is a difference in the distribution of operators according to visual acuity:  $>0.9$  -  $47.8 \pm 4.6\%$ ;  $38.3 \pm 4.5\%$  in the range of 0.6-0.9;  $13.0 \pm 3.1\%$  in the range of 0.3-0.6. Thus, the state of vision of railway workers varies depending on the age and work experience of employees in different countries, in different fields and in different professional groups. When these changes are not detected in a timely and professional manner, it causes professional disability among railway workers and as a result, the country's economy and human health suffer. An optimal ophthalmologic care model should be established to minimize potential damage. First of all, railway workers should undergo the complex ophthalmological examination while selecting for employment, only healthy people should be hired whenever possible.

For employment of those with eye pathology that does not cause professional disability implementation of eye examination twice is advisable, not once a year, as provided in the norm. In this case, the volume of preventive examinations will increase. Currently, 38% of employed machinists (259 of 682 persons) suffer from eye diseases not causing professional disability. Taking into consideration that the quantity of annual preventive examinations of  $N$  railway workers was planned as  $1.38N$  ( $M_{\text{preventive}}=1.38N$ ). The number of actual illnesses (Chapter III) varies with age: for railway workers aged <30; 30-39; 40-49; 50 and more (per 100 persons) was respectively  $35.8 \pm 3.7$ ;  $51.6 \pm 2.5$ ;  $65.6 \pm 1.5$  and  $65.3 \pm 1.7$ . The number of treatment diagnostic visits ( $M_{\text{md}}$ ) can be calculated by the following formula:

$$M_{MD} = \sum N_{\text{age} < 30} \times 0.358 + N_{\text{age} 30-39} \times 0.516 + N_{\text{age} 40-49} \times 0.656 + N_{\text{age} 50} \times 0.653$$

Treatment and prevention applications (visit) per 1 person is 0.58 at the locomotive depot; 0.57 - in the power supply group; 0.88 - in a steam washing station; 0.78 - in the communication group. The average data for railway system is 0.61.

Thus, total number of preventive and curative diagnostic visits was  $1.38N \pm 0.61N = 1.99N$ . Because most of the appeals consist of preventive examinations, the average annual workload of doctor ophthalmologist can be calculated as 10,000 visits. Currently, the annual workload of ophthalmologists in the Republic of Belarus is 11,000. Taking into account all this, it is necessary to plan 2 positions of ophthalmologist for ophthalmological care per 10,000 railway workers.

The activity of the ophthalmologist should be mainly focused on measures to detect professional disability in preventive examinations. The priority area for expertise of professional disability is an assessment of the visual acuity, binocular and color vision of machinists and machinist assistants.

In addition to those mentioned in preventive examinations implementation of Shirmer test is recommended. It was detected that the specific share of the registered persons of the normal flow of tears, depending on the profession of railwaymen, varies over a wide range: in 54.0-57.4% of locksmiths, in 54.0-587.1% of technicians; 56.5-58.2% of operators, 65.8-67.1% of electricians, 69.9-64.8% of

duty officers, 59.5% of mechanics, 61.4-62 washers, In 4%, normal tear flow was recorded in the road group in 58.1-63.6%. This figure only among drivers was higher (88.5-89.3%). There is information in the literature about light (21.4-42.8%), moderate (10.3-21.4%) and severe (0-3.6%) disruption of tear flow in railway workers of various professions. That is why the Schirmer test should be applied in preventive examination of railway workers, early treatment of detected pathologies can delay the development of dry eye syndrome.

In prophylactic examinations, application of the Schirmer test is recommended in addition to the full implementation of the minimum program (collection of anamnesis from patients, external eye, biomicroscopy, ophthalmoscopy, determination of visual acuity with and without correction, refraction, determination of color and binocular vision, determination of visual field, assessment of sharpness and sensitivity of twilight vision at recruitment, automatic refractometry) for the ophthalmologist.

The results of preventive examinations should be discussed with an ophthalmologist and labor safety engineers and measures to optimize working conditions (primarily lighting) should be justified.

### **ACHIEVED RESULTS**

1. Initial morbidity rate of eye pathologies per 100 railway works providing movement of trains ranges within the interval of  $14.3 \pm 1.9$  (in the car depot) -  $41.9 \pm 4.2$  (in the steam washing station), general morbidity  $22.6 \pm 2.3$  (in the car depot) -  $57.4 \pm 4.2$  (in the steam washing station) ) and the number of diseases detected in preventive examinations  $39.3 \pm 2.6$  (wagon depot) -  $62.5 \pm 4.1$  (at the steam washing station), refractive anomalies and conjunctivitis predominate in the nosological structure of the disease.
2. The risk of eye pathologies in railway workers depends on age, initial morbidity risk of associated with age and professional field changes within the interval of 3.4-8.5; general morbidity risk is 2.7-9.2; the prevalence risk of eye pathologies is 1.9 -7.5.
3. The risk of eye pathologies in railway workers depends on work experience, initial morbidity rate depending on work experience

among employees of the same age group changes within the interval of  $8.0 \pm 3.8$ - $18.8 \pm 2.6$  in the locomotive depot;  $10.7 \pm 5.8$ - $13.7 \pm 4.8$  in the wagon depot;  $26.7 \pm 11.4$ - $53.3 \pm 12.8$  at the steam washing station; in the range of  $11.1 \pm 6.0$ - $21.6 \pm 6.7$  in the group of communication workers and in the range of  $8.0 \pm 5.4$ - $20.8 \pm 5.8$  in the group of power supply, the total morbidity was  $28.0 \pm 6.4$ , respectively. -  $44.5 \pm 3.4$ ;  $25.0 \pm 8.1$ - $37.2 \pm 6.7$ ;  $53.3 \pm 12.8$ - $106.7$ ;  $25.9 \pm 8.4$ - $48.6 \pm 8.2$ ;  $20.8 \pm 8.0$ - $39.6 \pm 7.1$  per 100 persons.

4. Different professions in railway seriously affect the prevalence and changing of nosological structure of eye diseases: prevalence of diseases per 100 persons is less in the duty group ( $30.5 \pm 4.4$ ), and statistically higher in groups of operators ( $58.3 \pm 4.5$ ), electro-mechanics ( $48.5 \pm 5.0$ ), electricians ( $47.1 \pm 5.4$ ), technicians ( $46.9 \pm 5.0$ ), washers ( $45.0 \pm 4.7$ ), machinists and machinist assistants ( $43.5 \pm 1.8$ ) and locksmiths ( $40.2 \pm 5.2$ ), high risk of refractive anomalies in most professional groups, trauma and conjunctivitis in the washing group.
5. As the priority area of ophthalmic care in the railway system is prevention, 2.0 ophthalmologist positions per 10,000 people, 1.38 preventive examinations per year for a railroader, and an extended examination program (visual acuity, visual field, binocular and color vision, twilight vision, and Schirmer test) are required for meeting the current demand.

### **PRACTICAL RECOMMENDATIONS**

1. Individual planning of existing ophthalmological prophylactic examination program for railway workers taking into account the characteristics of their fields of work, professional activity, age and work experience is necessary.
2. Preventive examinations of railway workers with eye diseases that do not cause professional disabilities for recruitment should be carried out every 6 months

3. Tear flow of railway workers aged >40 with work experience >20 years should be assessed while preventive examinations, Shirmer test is recommended.
4. The current staffing norm of ophthalmologists is not acceptable for strengthening the prophylactic activities in the ophthalmic care of railway workers, therefore, it is recommended to adjust the staffing standard to the justified indicators.
5. The results of preventive examinations should be discussed with labour safety engineers, optimization of working conditions of railwaymen at risk of eye diseases and protection measures against harmful factors should be planned.
6. Control over the use of personal safety equipment by washers at the steam washing station should be strengthened.
7. To assess the twilight vision in the pre-trip examination of the driver and assistant drivers.

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The dissertation is available in the library of the National Center of Ophthalmology named after acamedician Z.Aliyeva.

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