Using Digital Biomicroscopy of the Eye for Comprehensive Diagnostics and Health Monitoring of Professional Education Students

Valeriy V. Bakutkin, Ilya V. Bakutkin, Dmitry A. Sukhov, Victotia P. Vereshchak, Vladimir A. Zelenov

For citation:
Bakutkin V.V., Bakutkin I.V., Sukhov D.A., Vereshchak V.P., Zelenov V.A. Using Digital Biomicroscopy of the Eye for Comprehensive Diagnostics and Health Monitoring of Professional Education Students. *Scientific Research and Innovation. 2021:2(3):72–77*
DOI:10.34986/MAKAO.2021.3.3.005

Authors' credentials:
Valeriy V. Bakutkin, Doctor in Medicine, Professor, Principal Research Scientist, International Academy of Consulting, Audit & Training, LLC, 34 Kirova St., Saratov 410012, RF
(bakutv@bk.ru)

Ilya V. Bakutkin, PhD in Medicine, Principal Research Scientist, International Academy of Consulting, Audit & Training, LLC, 34 Kirova St., Saratov 410012, (bakutiv@bk.ru)

Dmitry A. Sukhov, PhD in Physic and Mathematic, Director of the Enterprise Ref-Volga-Svet , LLC, Saratov, RF

Victotia P. Vereshchak, Intelligent Telemedicine LLC, Director General, Moscow, 107014, RF

Vladimir A. Zelenov, Director, International Academy of Consulting and Training, 34 Kirova St., Saratov, RF
(zelenov88@yandex.ru)

Conflict of interests:
The authors declare no conflict of interests.

Acknowledgments:
The study was conducted in accordance with the RFBR contract No. 18-29-02008 'Intelligent Laser System for Eye Surgery'.

Received: 11 August 2021
Revised: 10 September 2021
Published: 23 September 2021

Abstract: In this article, we present the results of comparing the outcomes of digital biomicroscopy of the eye vs. the background of original questionnaires for examined professional education students. Questionnaires detected no complaints in surveyed patients, which implied sufficiently high quality of their psychophysical condition. After the survey, their examination was conducted with a hardware-and-software appliance for digital biomicroscopy of the eye. The obtained results objectively evaluated the psychophysical condition of the subjects. The presented method allows for an opportunity of dynamic monitoring and comparison of obtained results. In existing epidemiological conditions, the possibility of remote examination is of particular importance.

Keywords: digital biomicroscopy, health monitoring, hardware-and-software appliance, pupillary responses, range of eye movement, telemedicine.

Introduction

Much attention is paid to the training of specialists in the system of professional education [1]. This is due to high expectations related to personal and professional qualities of future specialists [3]. Organization of medical examinations by educational institutions is regulated by the Labor Code of the Russian Federation. It is possible to identify health disorders in students only if they undergo regular medical examinations [2, 4]. The latter are carried out in order to identify the symptoms of exposure to harmful and/or hazardous production factors, conditions and diseases.

Health condition in students is influenced by many factors – in particular, by various somatic diseases, psychophysical fatigue, and use of psychotropic drugs. The equipment of examination rooms does not always ensure an adequate accuracy of diagnosis [5, 6, 7].

Our study aimed at analyzing the effectiveness of using digital biomicroscopy of the eye for comprehensive diagnostics and health monitoring in students in professional specialized education students.

Materials and Methods

Digital biomicroscopy of the eye is a non-invasive, safe procedure, based on digital methods of studying multiple indicators of the psychophysical condition of a student. The service includes questionnaires and methods of objective examination of indicators implying the presence of fatigue, inflammatory diseases, along with identifying the signs of drug and alcohol intoxication. For this purpose, high-precision sensors and diagnostic algorithms are used. The data based on survey results are archived, and are subject to comparative analysis. Both hardware and software are original, patented, and protected from falsification and unauthorized copying of information. This is provided by the methods of user identification by the iris of his or her eye.

The main goal of creating this service was to provide motivation for a healthy lifestyle, professional advancement, and monitoring of a student health condition.

The hardware-and-software complex of digital biomicroscopy of the eye, *Zenitsa 001*, was used in our study. According to the technical requirements, the appliance provides the following functions: obtaining data from digital biomicroscopy of the anterior eye segment with the ability to process the collected data in order to detect deviations of health indicators from the norm. The device is equipped with alcohol sensors to determine ethyl alcohol vapor concentrations in exhaled air.

This appliance allows using the following procedures:

- Initial survey about a subject's health condition;
- Identification of a subject by the iris;
- Analysis of pupillary responses;
- Determination of the redness level of the eyes;
- Identification of the eye movement ranges.

The hardware component of the complex has an ability to operate both from a 5V DC power supply and from a built-in battery. The duration of continuous operation of the device from a fully charged battery is six hours.

The device is controlled and data is transferred via the Internet. The hardware-and-software complex has two operating modes: manual and automatic. By default, when the device is turned on, automatic mode is active. To switch between the modes, it is necessary to press the corresponding button. Operability check of the blocks is carried out at the beginning of the device use by the '*Check'* program.

Research Procedure Description

Structure of surveyed groups and inclusion criteria:

- Students over 18 years old (randomly selected)
- Group size = 19 students.

Participant selection was made on a voluntary basis. All students meeting the inclusion criteria were asked to participate in the study. All those meeting the inclusion criteria and willing to participate signed *Voluntary Informed Consent to the Medical Care Provisioning within the Framework of Clinical Testing of the Methods of Prevention and Diagnostics.*

Study algorithm

- Initial survey on the condition of a subject
- Identification of ah examinee by the iris
- Analysis of pupillary responses
- Determining the level of eye redness
- Identifying the range of eye movements.

The study was carried out twice per day: before and after the classes. All medical examinations were carried out in a sitting position. After immobilizing the face of a subject, in accordance with the *User Guide*, we selected the sequence of examining the right eye, followed by the left eye. We used different lighting options in the order specified by the software. The results were saved in the form of a recorded original file, and a medical report based on the analysis results.

Additional information

- Instructions in case of possible deviations from the protocol;

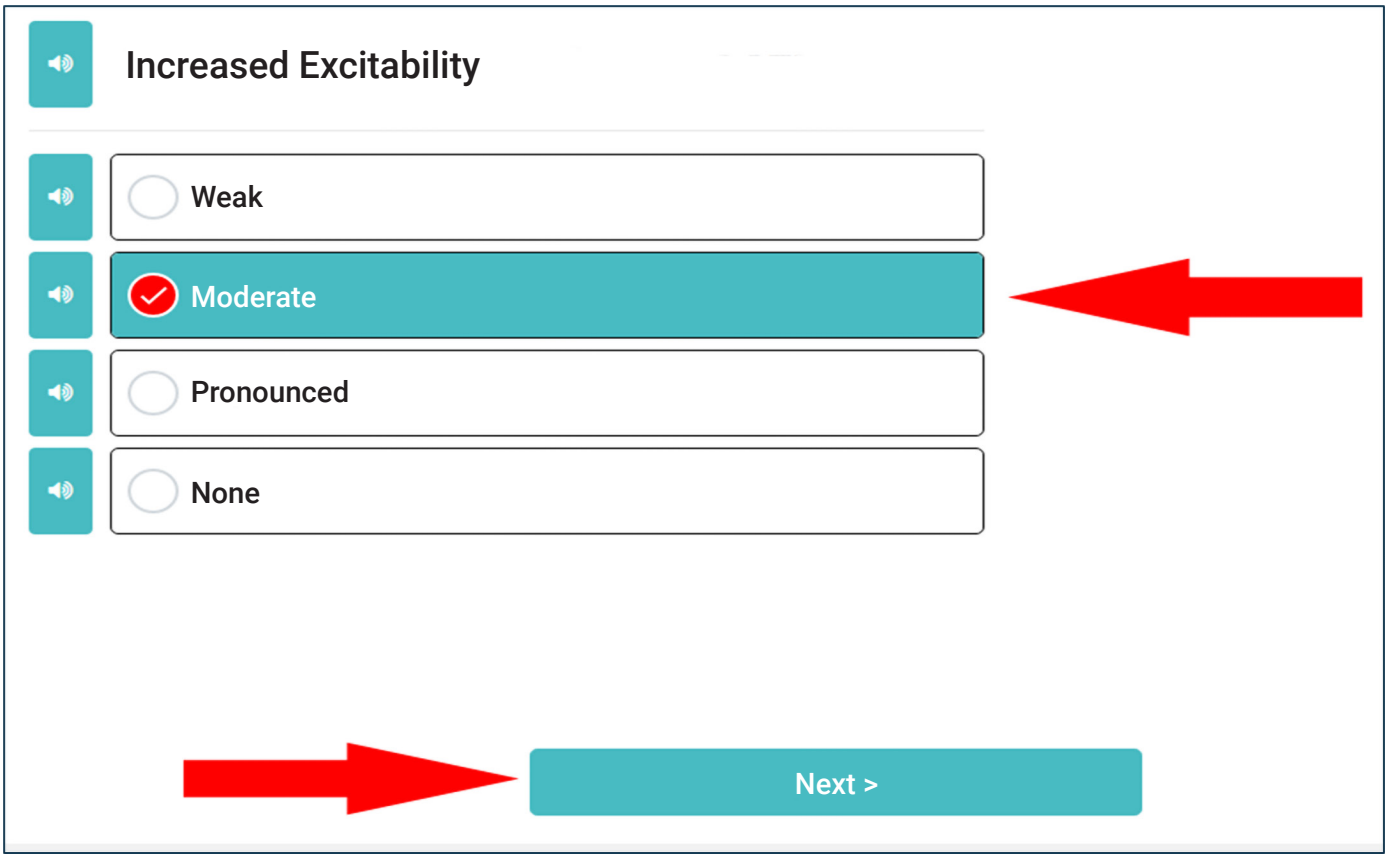

Figure 1. Analysis of responses in a patient medical record

■ Individual instructions for investigators on the protocol implementation;

■ Descriptions of specific research methods;

■ Normal values (reference ranges);

■ Instructions for the subjects.

The questionnaire was used by all subjects. The answers were given over the Internet communication channel via marking the corresponding options. The initial stage included a survey of a student in order to determine his or her psychophysical condition. We developed an Internet questionnaire available at http://intemsys.ru. The list of questions complied with existing standards. Answers were given sequentially, with the possibility of a quantitative assessment. Below are the sample fragments of the questionnaire.

Excerpts from the Questionnaire:

Choose you answer options:

1. Do you have any health complaints?
■ No
■ Yes:

- Pain
- Dizziness
- Weakness
- Impaired vision
- Other (specify).

2. How long did you sleep last night?
■ Over 8 hours
■ 6-8 hours
■ Less than 6 hours.

3. How do you rate your sleep?
■ High-quality, continuous sleep
■ Sleep disorder, difficulty falling asleep
■ Waking up at night.

4. Did you consume consumed alcoholic beverages in the past 24 hours?
■ Yes
■ No.

Figure 2. Telemedicine examination procedure

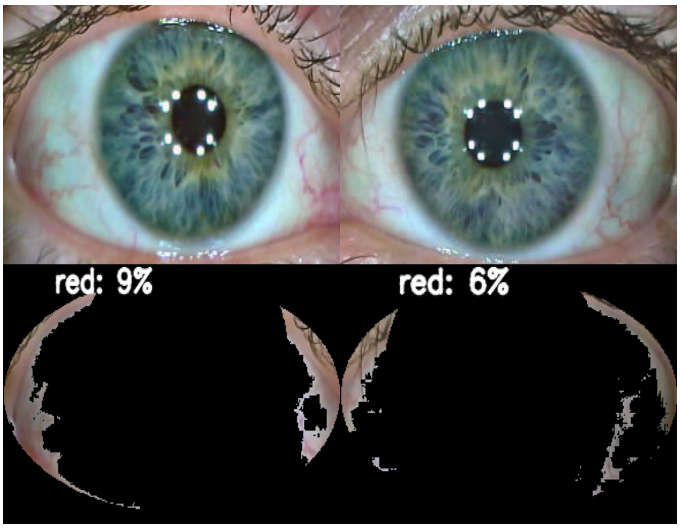

Figure 3. Pupillary responses

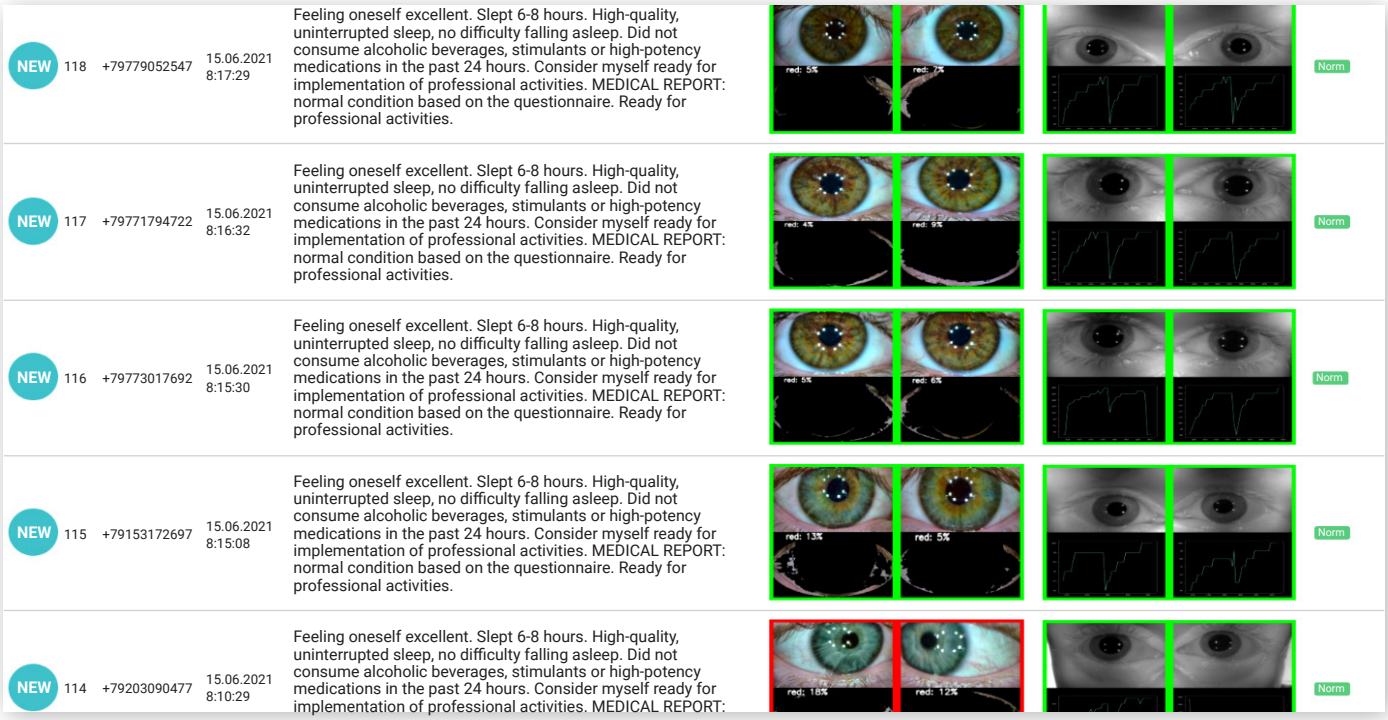

Figure 4. Range of eye movement

5. Did you use any stimulants or high-potency medications in the past 24 hours?
- Yes
- No.

6. Do you have increased excitability?
- Weak
- Moderate
- Pronounced
- None.

Responses to test questions were given directly by students. Accordingly, they were responsible for their accuracy. Responses were analyzed, and a reporting form was generated in text format and in the form of a graph for every participating student. In case of positive answers, students were sent for examination. Discrepancies between their statements

and an objective picture, served indications for medical examination.

The range of eye movements and pupillary responses made it possible to collectively assess the neuropsychiatric condition of every student.

Redness of the eye was classified as a *red eye syndrome*, indicating inflammation in the mucous membranes, or an increase in either blood or intraocular pressure. In the presence of such symptoms, the student was offered to undergo an additional medical examination.

The results were archived in the patient's folder. If there were deviations in the results from the physiological norm, then a message was generated to the medical worker in charge. If necessary, confirmation of the psychophysical condition was determined by conventional examination methods (medical tests, examination procedures).

Analysis of Obtained Results

Redness degree:

Redness area: R-9 %, L-6 %

Localization: R-I, L-IV

Maximum amplitude:
R - Amax=5 mm, L - Amax=5 mm;

Minimum amplitude:
R - Amin=2 mm, L-Amin=2 mm;

Range of changes:
R - dA=3 mm, L - dA=3 mm;

Response speed:
R- V=1 mm/s, L - V=1 mm/s.

Restrictions on the meridians: none

Conclusion

According to questionnaire summaries, no complaints were detected in surveyed patients. The latter possessed a good level of psychophysical condition. After the survey, an examination was carried out using a hardware-and-software appliance for digital biomicroscopy of the eye. The obtained results were objective: they collectively assessed the psychophysical condition of the subject. The method presents a possibility of dynamic monitoring and comparison of obtained results. In existing epidemiological conditions, the possibility of remote examination is of particular importance.

References

1. Gaisina. G.M. Opyt raboty po mediko-sanitarnomu obespecheniyu rabotnikov aviacionnoi promyshlennosti. G.M. Gaisina, R.V. Garipova, M.K. Kudryashova, R.V. SHaihutdinova. Profpatologicheskaya sluzhba v Respublike Tatarstan: istoriya, realii, perspektivy. Kazan'. 2004. P. 58–62. (In Russ.)

2. Amirov N.Kh, Berkheeva Z.M, Yakupov E.Z., et al. Current problems of medical observation of workers in unfavourable labour condition. *Kazanskij medicinskij zhurnal.* 2003; 84 (5):386-387. Available at: https://cyberleninka.ru/article/n/sovremennye-problemy-meditsinskogo-nablyudeniya-za-rabotayuschimi-v-neblagopriyatnyh-usloviyah-truda (In Russ.)

3. Kretov A.S., Bushmanov A.Yu., Mamonova E.Yu. Method of chronic occupational disease development risks assessment, and medical contra-indication. *Russian Journal of Occupational Health and Industrial Ecology*. 2015;(9):78-79. Available at: https://www.journal-irioh.ru/jour/article/view/205?locale=en_US (In Russ.)

4. Bushmanov A.U., Kretov A.S., Kasymova O.A., et al. The formation of risk groups for development of occupational diseases during the pre-employment and periodic medical examinations to conduct recreational activities. *Saratovskij nauchno-medicinskij zhurnal*. 2014;10(4):754–758. Available at: https://cyberleninka.ru/article/n/formirovanie-grupp-riska-razvitiya-professionalnyh-zabolevaniy-v-hode-predvaritelnyh-i-periodicheskih-meditsinskih-osmotrov-dlya/viewer. (In Russ.)

5. Bojko I.V. The work of the therapist with patients in the detection of signs of occupational diseases. *Terapevt.* 2011;7:12–16. (In Russ.)

6. Vigdorchik N.A., Zil'ber D.A., Matusevich Ya.Z. et al. Medical contraindications to employment]. Leningrad: Leningradskij institut po izucheniyu professional'nykh zabolevanij, 1929. 103 p. (In Russ.)

7. Khoruzhaya O.G., Pictushanskaya T.E., Gorbljansky Yu.Yu. Evaluation of workers' periodic medical examinations quality. *Russian Journal of Occupational Health and Industrial Ecology*. 2015;(12):41–44. Available at: https://www.journal-irioh.ru/jour/article/view/409 (In Russ.)