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Evaluating the impact of blue light blocking glasses on patients suffering from age-related macular degeneration

Ocena wpływu okularów blokujących niebieskie światło na pacjentów cierpiących na zwyrodnienie plamki żółtej związane z wiekiem

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Abstract

Background. *Age related macular degeneration (AMD) is a degenerative disease that affects the retinal pigment epithelium (RPE) and photoreceptors in the macula. AMD is a leading cause of blindness among elderly people. AMD progresses to advanced stages of the disease, atrophic AMD or in 15% of cases to neovascular AMD, associated with substantial vision loss.* **Aim.** *The study aimed at finding out the effectiveness of blue light blocking glasses and their impact on improving visual performance in case of phakic and pseudophakic patients suffering from age-related macular degeneration.* **Methods.** *To collect data, Macular Dazzling Test was performed on 54 healthy volunteers and on 76 patients suffering from AMD. Each patient was tested twice without glasses and twice with them on. Each eye was tested separately during each cycle.* **Results.** *According to the analyzed data, the use of blue light glasses reduced the average readaptation time among the healthy population by 3.8 seconds (n = 108, CL = 99%, p <0.05). In the population of patients suffering from age-related macular degeneration, the average time needed for retinal regeneration was reduced by 26.5 seconds (n = 76, CL = 95%, p <0.05). Increase in intraocular pressure proved to decrease time on average by 12.7 seconds (n = 76, CL = 99%, p <0.05). In the population of patients that underwent cataract surgery, the use of blue blocking glasses resulted in no apparent advantage.* **Conclusions.** *The results show that blue light-blocking glasses significantly decrease the time needed to complete retinal regeneration among the healthy population and patients suffering from AMD. Moreover, the studies confirmed that blue light leads to a reduction in the physiological function of the retina much more in AMD patients and that the use of glasses with blue light filters can significantly improve readaptation time among patients suffering from macular degeneration. (Gerontol Pol 2024; 32; 149-158) doi: 10.53139/GP.20243218*

Keywords: *age-related macular degeneration, retinal protection, blue light blocking spectacles*

Streszczenie

Wstęp. *Zwyrodnienie plamki żółtej związane z wiekiem (AMD) jest chorobą zwyrodnieniową, która obejmuje nabłonek barwnikowy siatkówki (RPE) oraz fotoreceptory plamki żółtej. AMD jest główną przyczyną ślepoty wśród pacjentów ge-*

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riatrycznych. U większości chorych, progresja AMD do zaawansowanych stadiów choroby takich jak do zanikowego AMD lub do AMD z neowaskularyzacją siatkówki, wiąże się ze znacznym ryzykiem utraty wzroku. Cel. *Badanie miało na celu ustalenie skuteczności okularów blokujących niebieskie światło i ich wpływu na poprawę wydajności widzenia w przypadku pacjentów fakijnych i pseudofakijnych cierpiących na zwyrodnienie plamki żółtej związane z wiekiem.* **Materiały i metody.** *W celu zebrania danych przeprowadzono test olśnienia plamkowego (MDT) u 54 zdrowych ochotników i 76 pacjentów cierpiących na AMD. Każdy pacjent został przetestowany dwukrotnie bez okularów i dwukrotnie z założonymi okularami. Każde oko było badane oddzielnie podczas każdego cyklu.* **Wyniki.** *Zgodnie z prze analizowanymi danymi, zastosowanie okularów z filtrem blokującym światło niebieskie skróciło średni czas potrzebny do readaptacji siatkówki wśród osób zdrowych o 3,8 sekundy (n = 108, CL = 99%, p <0,05). W populacji pacjentów cierpiących na zwyrodnienie plamki żółtej związane z wiekiem, średni czas potrzebny na regenerację siatkówki został skrócony o 26,5 sekundy (n = 76, CL = 95%, p <0,05). Wzrost ciśnienia wewnątrzgałkowego skrócił czas średnio o 12,7 sekundy (n = 76, CL = 99%, p <0,05). Wśród pacjentów, którzy przeszli operację zaćmy, stosowanie niebieskich okularów blokujących nie przynosi widocznych korzyści.* **Wnioski.** *Wyniki pokazują, że okulary blokujące niebieskie światło znacznie skracają czas potrzebny do pełnej regeneracji siatkówki wśród osób zdrowych i pacjentów cierpiących na zwyrodnienie plamki żółtej związanej z wiekiem. Co więcej, badania potwierdziły, że niebieskie światło prowadzi do zmniejszenia fizjologicznej funkcji siatkówki w znacznie większym stopniu u pacjentów z AMD oraz że stosowanie okularów z filtrami niebieskiego światła może znacznie poprawić czas readaptacji wśród pacjentów cierpiących na zwyrodnienie plamki żółtej i tym samym poprawić ich jakość życia. (Gerontol Pol 2024; 32; 149-158) doi: 10.53139/GP.20243218*

Słowa kluczowe: *zwyrodnienie plamki żółtej związane z wiekiem, ochrona siatkówki, okulary blokujące światło niebieskie*

Background

Age-related macular degeneration (AMD) stands as one of the most prevalent causes of irreversible vision loss among the elderly population worldwide [1,2]. AMD primarily affects the macula, a region in the central retina responsible for detailed and central vision [3].

As life expectancy continues to rise globally [4], the negative influence of AMD on public health is expected to escalate, rendering it a significant challenge in ophthalmology and geriatric medicine [2,3]. The development of the disease is strongly associated with age [3] and is considered as a major challenge in ophthalmology of the XXI century. According to the United Nations, the share of the global population above 65 years old is projected to rise from 10 per cent in 2022 to 16 percent in 2050 [5,6].

In view of this and according to other prognosis, AMD will become a major challenge for the world's healthcare systems. In the 2020 global population suffering from AMD at any stage was projected to reach 196 million and is expected to increase up to 288 million [7]. Taking into consideration the fact 69 million Europeans and 113 million Asians are expected to suffer from AMD in 2040, in comparison to 58.78 million of Europeans and 70.68 million of Asians in 2020 [7], health institutions are needed to be properly prepared for this growth. This applies also to the United States where Centers for Disease Control and Prevention (CDC) estimate the number of patients suffering from AMD in 2019 at 19.8 milion [6], and this number is estimated to grow up to 26 million in 2040 [7]. According to the CDC's report, the prevalence of AMD fluctuates, from 13.31% among people 65-69 years old to 60.35% among 95-99 years old [6]. On the other hand, residents of Latin America and Africa are, thanks to younger populations, much less threatened with respectively 38.53 in Latin America and 39.06 million in 2040, in comparison to 24.80 and 20.29 million in 2020. The least AMD cases are expected to come from The Oceania with 1.62 million in 2020 and 2.40 million in 2040 [7].

Before complete vision loss, patients suffering from AMD complain about blurry or fuzzy vision, loss of central vision which is necessary for daily activities such as reading or driving- this can be impossible even at the first stage of the disease, especially when we consider exposure to the car lights driven in the opposite direction. That can lead to abandonment of usual activities or lack of employment and can strongly affect the patient's life.

One of the most significant factors in development of AMD is blue light exposure [12]. Long term of blue light exposure frequently results in excessive production of oxygen free radicals also known as reactive oxygen species (ROS) and this leads to oxidative stress in mitochondria's of retinal pigment epithelium cells [13]. Oxidative stress occurs when an organism's natural ability to removal of produced reactive oxygen species (ROS) is inefficient, which results in accumulation of them [12,13]. Accumulation of oxygen free radicals and oxidative stress causes severe damages of the DNA and triggers mitochondria-involved death signaling pathways leading to death of retinal cells. This is especially dangerous because RPE has proven to performing vital functions for retina such as formation of outer blood-retinal barrier, transepithelial transport, maintenance of retinoid cycle, phagocytosis, degradation of photoreceptor outer segment tips and protection against oxidative stress [13]. This is the reason why RPE damage is strongly linked [13,14] with subsequent development of dry AMD and why blue light exposure is so significant in AMD development.

Our research was conducted in order to find the possible impact of using blue-light blocking glasses among AMD population on their retina readaptation time and therefore the possible impact on their quality of life.

Materials and methods

The study was conducted at prof. K. Gibiński University Clinical Center of Medical University of Silesia in Katowice. The consent from the Bioethics Committee operating at Medical University of Silesia was obtained for the study: Resolution No.PCN/CBN/0022/KB1/140/21/22. All patients provided written informed consent before participation.

Recruitment

Fifty-nine participants with the average age of 68 from the treatment group were recruited from patients of the AMD clinic operating at prof. K. Gibiński University Clinical Center in Katowice. Out of those fifty-nine patients which mark one hundred eighteen eyes in total, seventy-six eyes met inclusion criteria and were tested. Among those seventy-six eyes that were tested, twenty-eight had undergone cataract surgery before (pseudophakic) our experiment. The control group consisted of fifty-four healthy volunteers- one hundred eight healthy eyes in total.

Inclusion criteria:
- 18 years of age or older
- Consent for taking part on every step of the experiment
- Dry AMD

Exclusion criteria:
- Refraction error of more than -4 dioptres
- Decreased clarity of optic media
- Eye diseases (excluding AMD)
- Abnormalities in the alignment and mobility of the eyeballs
- Neurological disorders
- Chronic oncological treatment
- Chronic immunosuppression

Procedures

Our experiment was done with the use of Macular Dazzling Test (MDT) [15] and was carried out in three steps: in the first step we were measuring intraocular pressure using non-contact tonometer, the second step involved evaluation of visual acuity on Snellen chart from the distance of 3 meters. During the third step a patient was instructed to look directly into the source of the light while the dazzle was produced using the ophthalmoscope located 10cm from the patient's cornea (and 1.5-2 cm from glasses when patient had them on). In this case the dazzle exposure lasted for 10 seconds. The chronometer was set in motion at the instant when the dazzle was produced. The recording of the recovery time began with the chronometer stopping when the patient regained his visual acuity as before the dazzling.

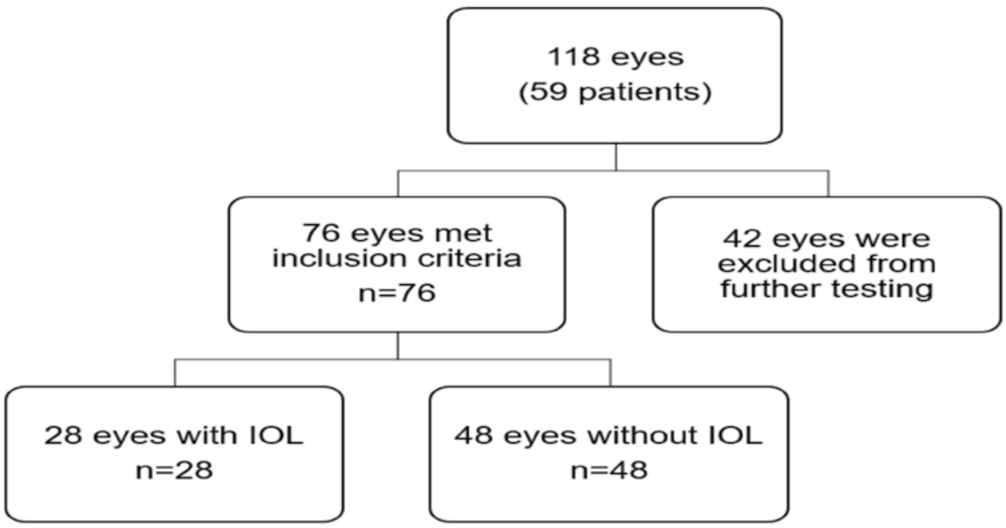

Figure 1. Analysis of participants of the study

In our experiment we used blue-light blocking lenses with the range of blockage 380-500 nm blue light spectrum, with the maximum of 50% at 400 to 500 nm.

Statistical analysis

All measurements gained during the experiment were subjected to statistical analysis. The obtained results were tested using the Shapiro-Wilk test. The aim of statistical analysis was to verify the hypothesis that the usage of blue-light blocking glasses leads to decrease in time needed for complete retina regeneration and regaining visual acuity among both healthy patients and those suffering from age-related macular degeneration.

Results

Control group

According to statistical analysis, presence of blue light blocking lenses decreased mean reaction time needed for complete retina regeneration by 3.81 seconds (CL = 99%, $p < 0.003$) for the whole control group. Interestingly, when control group is divided due to presence of refractive error, difference in reaction time is much better prominent among participants with refractive error where time after performing MDT in glasses is reduced by 5.83 (CL = 95%, $p = 0.0647$) in comparison to those without refractive error where mean reaction time was reduced by 2.87 seconds (CL = 95%, $p = 0.0647$). Presented data shows that for a healthy population, reduction of exposure to the blue light leads to the decrease of time needed for complete retina regeneration; however people with visual impairment tend to present decreased retina's regeneration mechanisms, as their common mean time is much longer when compared to mean time of those without visual impairment. Whole comparisons of those subgroups with more statistical data is presented in table I.

It is worth mentioning that range of mean times, measured after performing MDT on a control group with

Table I. Mean reaction times [s], standard deviations and frequencies for the control group

	Statistical data	No refractive error	Refractive error	Total
Without filter	Mean	26.897308	40.762222	31.275702
	SD	11.036131	16.524819	14.473295
	Frequency	78	36	114
Blue light filter	Mean	24.017564	34.928611	27.463158
	SD	8.1189081	12.485936	10.915787
	Frequency	78	36	114
Total	Mean	25.457436	37.845417	29.36943
	SD	9.764093	14.835458	12.932183
	Frequency	156	72	228

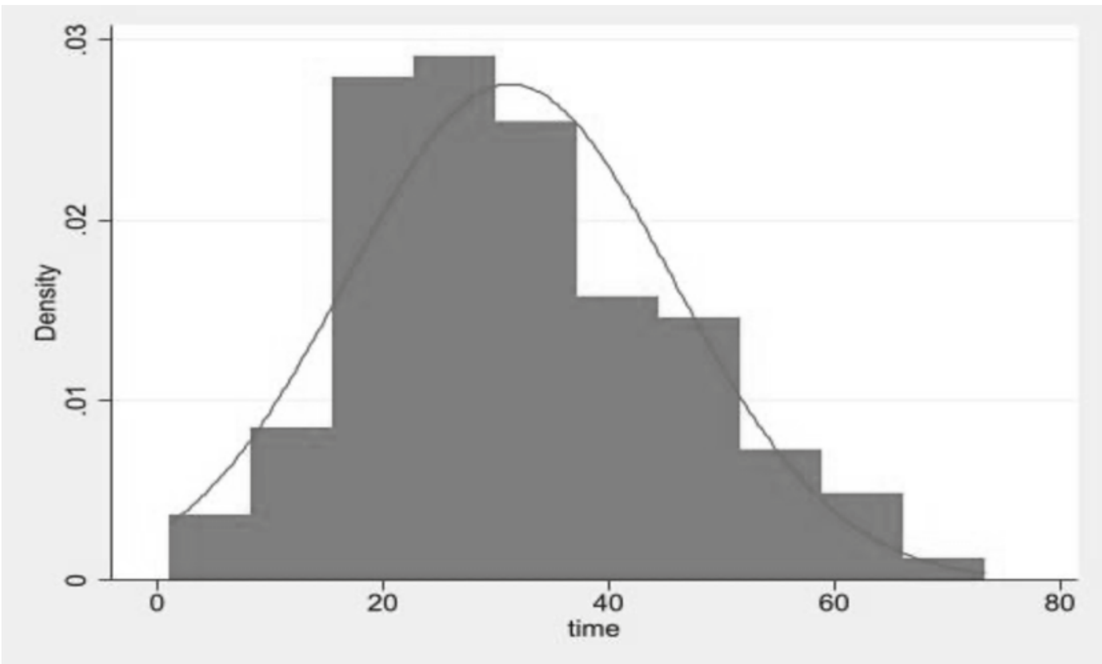

Figure 2. Distribution of the time [s] in the control group without blue light blocking lenses

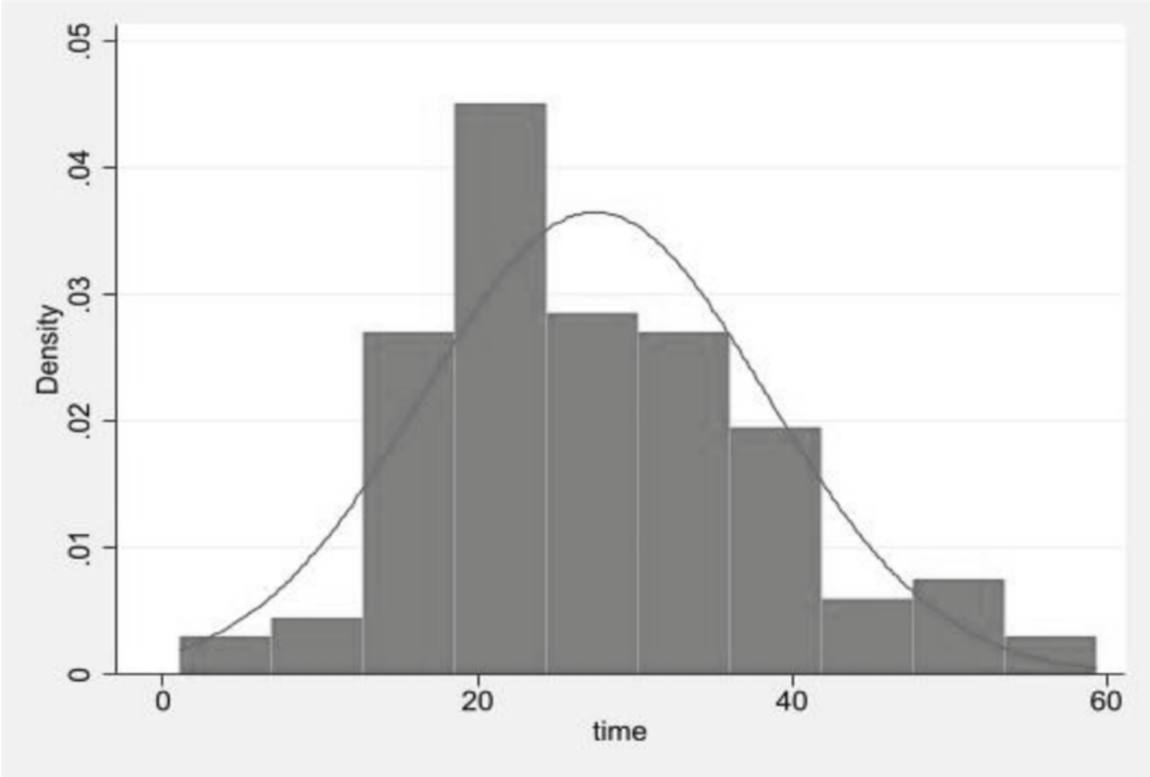

Figure 3. Distribution of the time [s] in the control group with blue light blocking lenses

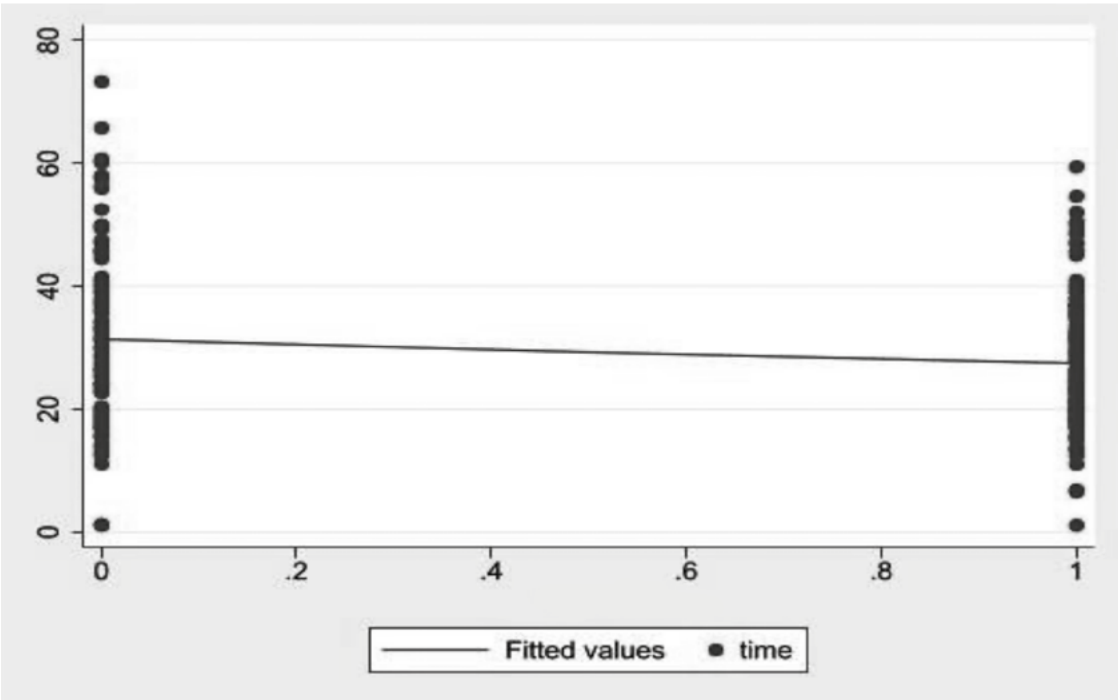

Figure 4. Changes of time [s] in control group where 0 is group tested without blue light filter and 1 is time measured with blue light filter

glasses is visibly more, narrow than this measured without them. This proves that blue light blocking glasses decrease time for the non-AMD population. Distribution of times without blue light blocking lenses is presented on figure 2 and distribution of times with them is presented on figure 3. If we compare two of these charts, we notice that the use of blue light filters reduces the maximum time needed for retina regeneration under 60 seconds. Also, blue light filter significantly increase the amount of healthy people with reaction time within normal range (under 50 seconds). This can lead to the conclusion that use of blue light blocking glasses should be recommended to everyone.

Graphic comparison of those two subgroups is presented on figure 4. This comparison shows us narrowing the range of results and decrease in mean results after wearing glasses.

Treatment group

When we divide the treatment group between phakic and pseudophakic patients, the results differ from each other. According to statistical analysis, patients suffering from AMD without intraocular lenses have experienced a decrease in time needed for complete retina regeneration was reduced by 26.5 seconds after the use of blue light blocking glasses ($p < 0.03$). What is more interesting, statistically the use of glasses did not have any statistical influence on the reaction time among pseudophakic patients, despite the fact that their mean reaction time after test in glasses was shorter than without them.

An increase in the intraocular pressure by 1 mmHg proved to decrease the time by 12.7 seconds, which is an interesting observation (confidence level >99%, $p < 0.01$).

Patients that underwent cataract surgery had lessen time by 75.2 seconds in comparison to those without intraocular lens ($n = 28$, confidence level = 95%, $p < 0.02$), but use of blue light blocking glasses resulted in no apparent advantage.

Distribution of times without blue light blocking lenses is presented on figure 5 and distribution of times with them is presented on figure 6.

Intraocular lenses have an impact on time distribution among those who are suffering from AMD, which is clearly shown when we compare data shown on figure 7 and figure 8. On the figure 8 is clearly visible that among patients with IOL there are significantly more

Table II. Mean reaction times [s], standard deviations and frequencies for the treatment group

	Statistical data	Without IOL	With IOL	Total
Without filter	Mean	94.493021	68.815714	
	SD	91.1234	58.173838	
	Frequency	96	56	152
Blue light filter	Mean	76.513021	61.200179	70.871447
	SD	67.061012	61.354654	65.233507
	Frequency	96	56	152
Total	Mean	85.503021	65.007946	77.952204
	SD	80.299815	59.638271	73.929962
	Frequency	192	112	304

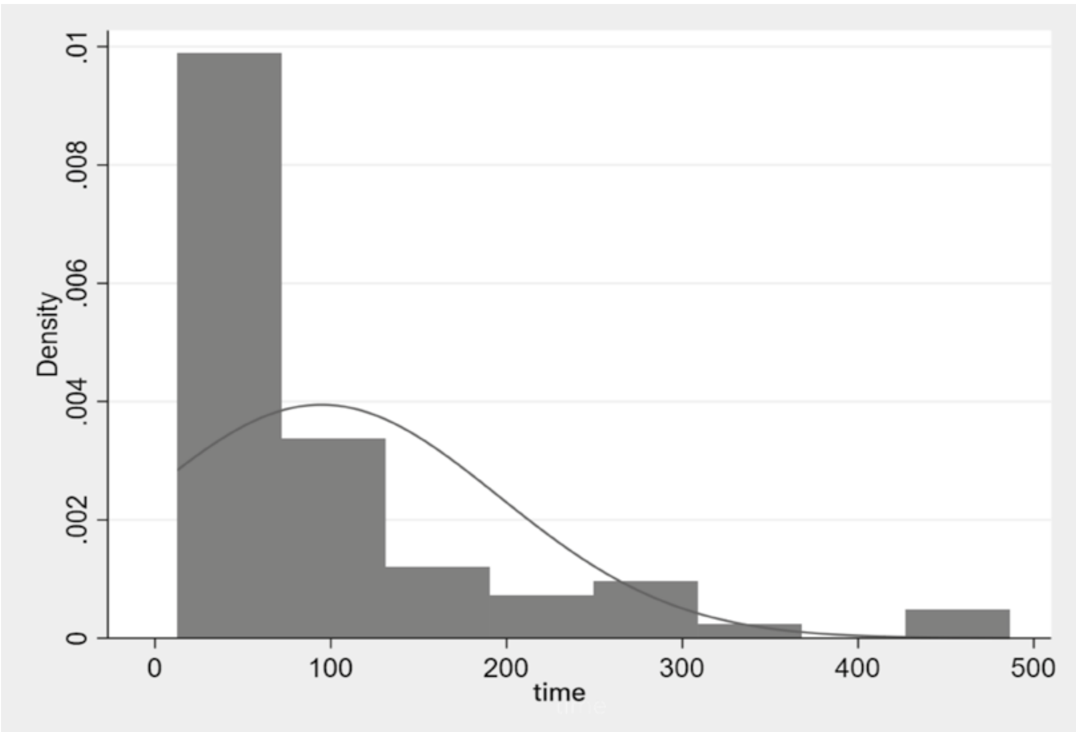

Figure 5. Distribution of the time [s] in the AMD group without blue light blocking lenses

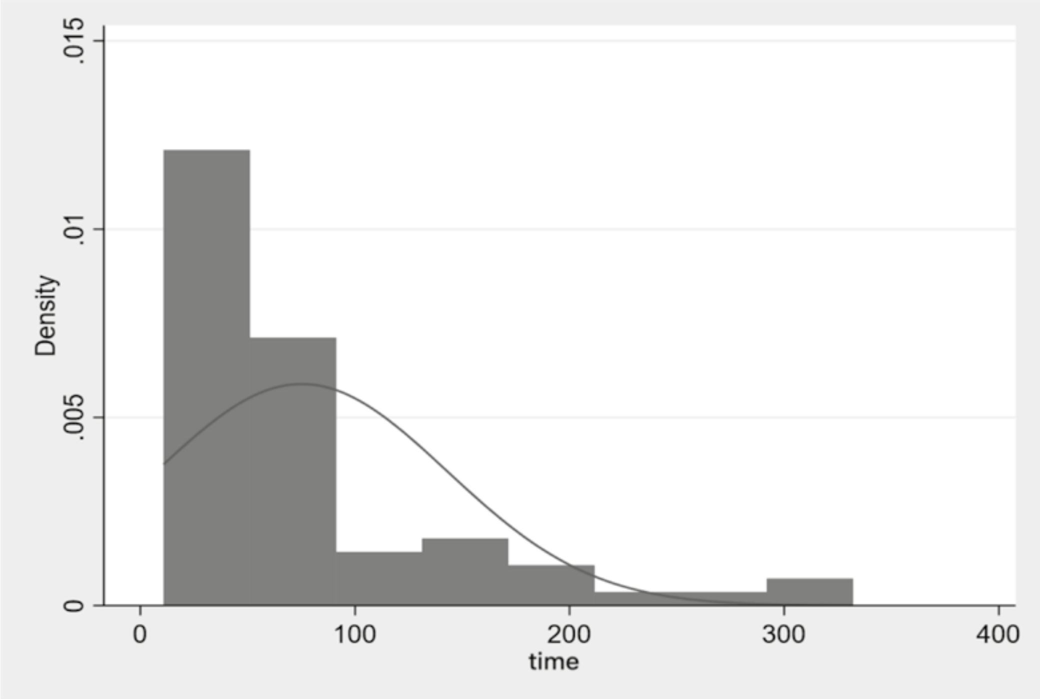

Figure 6. Distribution of the time [s] among AMD group with blue light blocking lenses

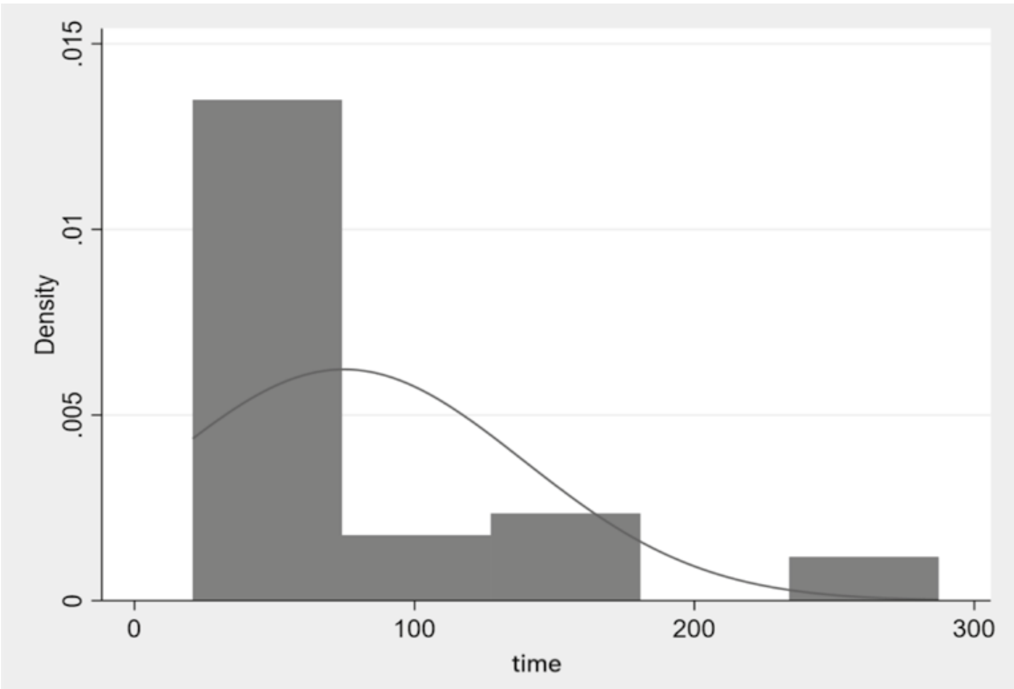

Figure 7. Distribution of the time [s] among AMD group with IOL (intraocular lens) without blue light blocking lenses

results with lower response time in comparison to figure 7 which has a much wider range of results that is also confirmed in table 2.

Figure 9 shows us a graphic comparison of reaction times before wearing blue blocking lenses and after wearing them. As we can see, the average reaction time is lower after testing with glasses, which supports the hypothesis. It is also particularly noticeable that even the highest results tested without glasses managed to significantly reduce under the influence of the blue light filter.

Discussion

Blue-blocking spectacle lenses with varying degrees of short-wavelength light attenuation were, for the long period of time, being advertised as a modern solution for modern problem- which is huge exposure to blue light by everyday technology. Blue light in the general population is responsible for dry eyes syndrome, computer vision syndrome, sleep disorders or was under suspicion of having an impact on bipolar disorder [16,17].

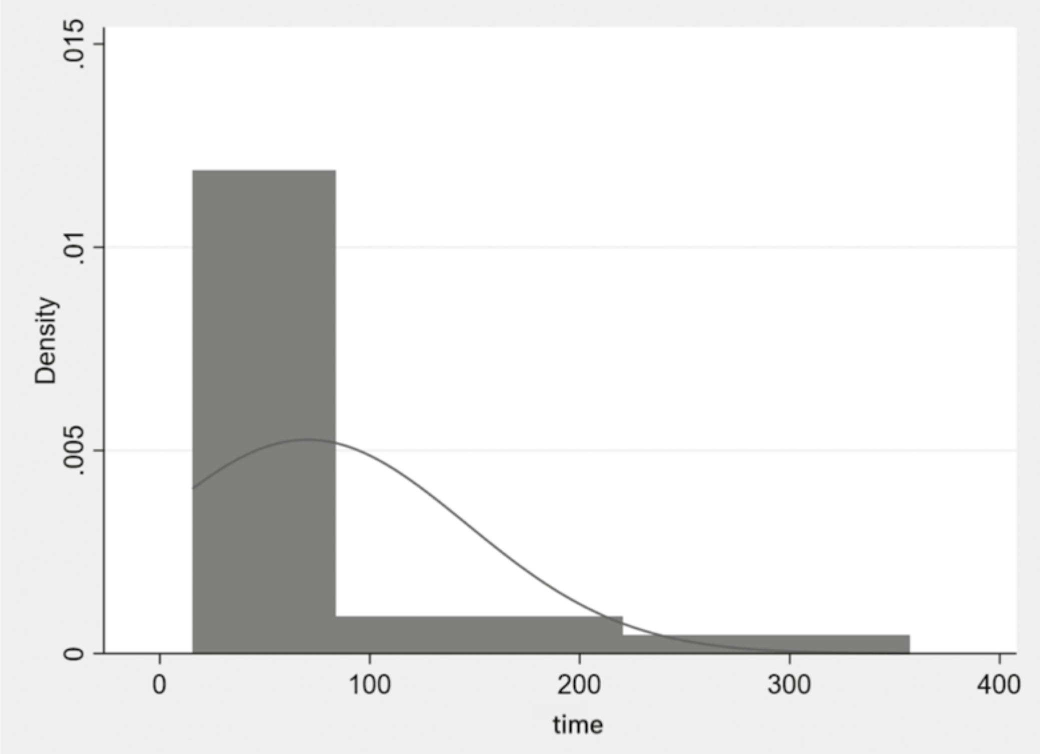

Figure 8. Distribution of the time [s] among AMD group with IOL (intraocular lens) with blue light blocking lenses

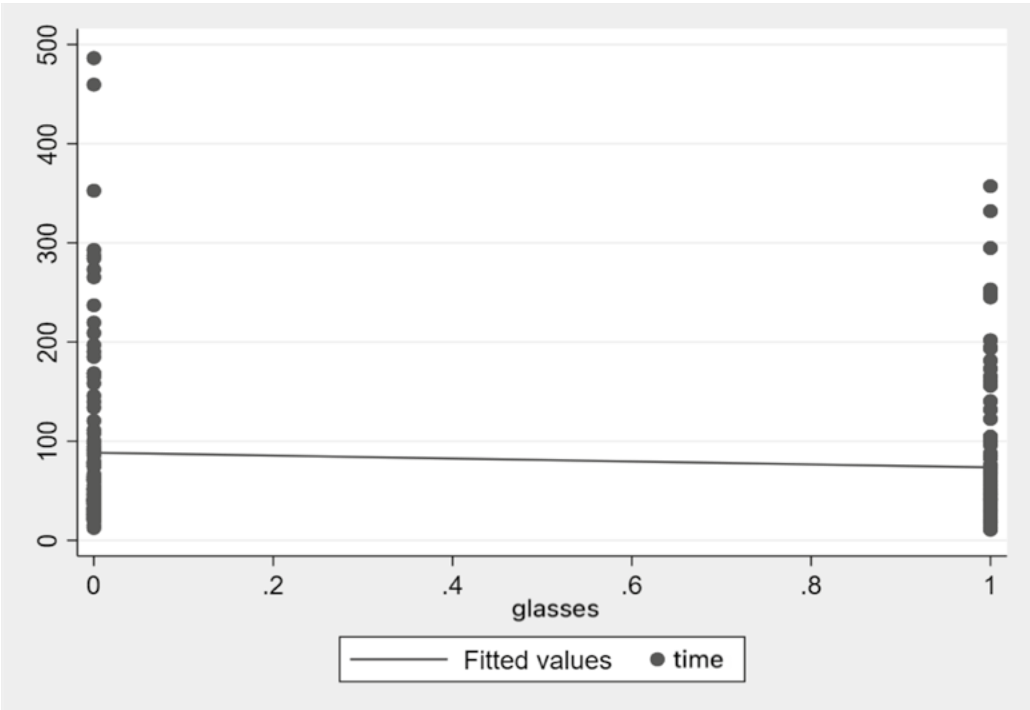

Figure 9. Changes of time [s] among AMD patients in relation to being tested without [0] and with blue light filter [1]

Our results show that blue light-blocking glasses significantly decrease the time needed to complete retinal regeneration among the healthy population by 3.81 seconds ($p < 0.003$) and patients suffering from AMD by 14.16 seconds ($p < 0.03$). The result of the control group is not spectacular, but worth mentioning is that the majority of healthy individuals are drivers- it would be advised for them to consider wearing blue light spectacles when there is a risk of blue light exposure or during nighttime rides when they are exposed to large changes in light intensity.

Our study confirmed that blue light leads to a reduction in the physiological function of the retina much more among AMD patients. This leads to the conclusion that damaged retina presents much bigger vulnerability to the effect of blue light straightforwardly with the size of damages. Taking into consideration that AMD is considered as untreatable, blue light spectacles can be one of the major factors in AMD prevention and chronic treatment along with vitamins and VEGF agents [18].

The use of glasses with blue light filters can significantly improve readaptation time among patients suffering from macular degeneration. This can not only help in stopping disease's progression but can also be helpful for patients in various areas of life. Patients suffering from AMD are not able to do many activities when they experience a limited amount of light which makes driving or walking at night impossible even for those at the early stage of the disease. This can make blue light lenses an "game changer" for them.

It is interesting to note that blue light spectacles did not have a major impact on those pseudophakic patients. The most probable explanation is that in most artificial intraocular lenses that are used for operational treatment of cataract in polish hospitals, the manufacturer provides that filter during the production process. This would make blue light spectacles completely useless for this group and would make cataract surgery as one of AMD prevention factors. This however, requires further investigations.

Also, the impact of intraocular pressure (IOP) is also thought-provoking. Increase in IOP by 1 mmHg proved to decrease time by 12.7 seconds ($p < 0.01$), which is an interesting observation. To this day, it is proven that there is no negative impact of increased IOP or glaucoma [19] although glaucoma tends to occur more commonly among those with advanced AMD . The result is also interesting when we consider the fact that both AMD and glaucoma have common risk factors such as sleep apnoea [20,21]. There is a need for high quality studies to check that connection.

Conclusions

The results show that blue light-blocking glasses significantly decrease the time needed to complete retinal regeneration among the healthy population and patients suffering from AMD. Moreover, the studies confirmed that blue light leads to a reduction in the physiological function of the retina much more in AMD patients and that the use of glasses with blue light filters can significantly improve readaptation time among patients suffering from macular degeneration.

Konflikt interesów/ Conflict of interest
Brak / None

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