Evaluation of the effects of hyperbaric on human attention functions based on eye movements recorded using an infrared camera

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Abstract

Background. This study aimed to assess the influence of elevated atmospheric pressure on the functions of attention of medical personnel working in hyperbaric chambers. We enrolled 15 participants who met the inclusion criteria. The test consisted of performing the same medical procedure under 2 conditions. For each of these test conditions, right eye movements were recorded using an oculograph. The obtained results revealed a relationship between elevated atmospheric pressure and the ability of medical personnel to focus.

Objectives. To assess the influence of hyperbaric oxygen (HBO_2) on visual attention in medical personnel during medical activities performed under normobaric (1 absolute atmosphere (1 ATA)) and hyperbaric (4 ATA) conditions inside a hyperbaric chamber.

Materials and methods. Each participant had a valid license to act as a medical attendant during therapeutic hyperbaric sessions. Fifteen individuals, 10 men and 5 women aged between 28 and 65 years, participated in the study. The participants were asked to perform a medical procedure involving the preparation of a syringe with a drug administered by an infusion pump under 2 test conditions: 1 ATA corresponding to the atmospheric pressure on land, and 4 ATA corresponding to an underwater depth of 30 m. The order of test conditions was random. Both test conditions were performed inside a hyperbaric chamber.

Results. The number of fixations in the area of interest (AOI) varied between stages (1, 2 and 3) and task conditions (1 ATA and 4 ATA), with lower values for the 4 ATA condition. Under 1 ATA, 30% of eye fixations were in the AOI, as compared to only 6% under 4 ATA.

Conclusions. The obtained results indicate that elevated atmospheric pressure has negative effects on the attention of medical personnel.

Key words: hyperbaric therapy, attention, oculography, medical staff

Background

Although hyperbaric oxygen (HBO2) therapy has been used for decades, it has evolved over the last quarter of a century, with an increase in the number of indications for this treatment modality. Currently, the use of technology based on patient exposure to artificially increased pressure is justified in the emergency and elective treatment of multiple clinical entities. It is employed both as a therapy of choice, e.g., in carbon monoxide poisoning or decompression sickness, and as an adjunctive treatment.[1] Multi-profile indications for the use of HBO2 include such disease entities as burns, difficult-to-heal wounds, osteoarthritis, ischemic skin loss, sudden hearing loss, as well as acute hemorrhagic anemia.[2] In the last 2 decades, the list of indications for HBO2 was extended to include locomotor trauma with severe edema and inflammation – conditions which often reduce proper oxygen saturation in the tissues at the site of injury due to their dynamic nature, compromising the efficacy of surgical treatment.[3]

The growing awareness among clinicians of hyperbaric medicine translates into an increasing recognition of this discipline and its implementation in everyday therapeutic management. It is important to point out that medical personnel accompany the patient in the pressure chamber to guarantee proper therapy and safety during therapeutic compression sessions in the clinical setting. Therefore, the present study shows the impact of increased atmospheric pressure on attention in medical personnel performing their professional duties in pressure chambers that may contribute to therapeutic safety.

Objectives

In a clinical hyperbaric environment, medical personnel are exposed to the same pressure values as patients during a therapy session. Previous studies have shown that oxygen therapy under pressure above 1 atmosphere has a beneficial effect on improved cognitive function in healthy elderly people, as well as in those who have suffered brain damage due to stroke or craniocerebral trauma.[4,5] However, the effect of HBO2 on cognitive functions described in the literature refers to the results obtained after completing a therapeutic compression cycle. Marine literature shows that a hyperbaric atmosphere may have a negative effect on central nervous system (CNS) functions in situ.[6,7] The main objective of our study was to assess the influence of HBO2 on visual attention in medical personnel during medical activities performed under normobaric (1 absolute atmosphere (1 ATA)) and hyperbaric (4 ATA) conditions inside a hyperbaric chamber.

Materials and methods

The study was conducted in 2019–2021 as part of an in-house project, one of the main objectives of which was to evaluate the effect of HBO2 on the attention capacity of medical professionals working in hyperbaric medicine units. The research was initiated after obtaining the approval of the Bioethics Committee at the Military Medical Institute in Warsaw, Poland (approval No. 22/WIM/2018 issued on April 17, 2019).

All participants received oral and written information about the research and provided written informed consent to participate in the study. Data on the participants (medical history, physical examination and results of the tests performed) were collected on forms prepared for this purpose and on electronic devices dedicated only for the purposes of the research. The obtained data were archived at the Clinical Department of Hyperbaric Medicine of the Military Medical Institute in Warsaw in accordance with the current regulations on data anonymity.

Each participant was authorized to act as a medical attendant during therapeutic hyperbaric sessions. Fifteen individuals (13 nurses and 2 medical doctors, including 10 men and 5 women) aged between 28 and 65 years (mean (M) = 38.47; standard deviation (SD) = 5.77), participated in the study (Table 1).

Study inclusion criteria were as follows: 1) written informed consent to participate in the study; 2) medical education and valid license to work in a clinical hyperbaric setting; 3) no significant disease of the right eyeball; 4) no contraindications to the study.

Individuals with one or more of the following criteria prior to the study: pregnancy, otitis media, visual impairment, cardiac arrhythmia, and general malaise, were not allowed to participate in the study. At the time of qualification for the study, no participant met these exclusion criteria. Each participant had a paired visual organ that did not exclude them from professional activities due to dysfunction.

Table 1. Characteristics of study participants

Age	Participants (n = 15)	Male (n = 10)	Female (n = 5)
M	39.33	41.6	34.8
SD	9.32	10.29	5.22
Min	28.0	31.0	28.0
Me	36.0	39.0	36.0
Max	65.0	65.0	42.0

M – mean; SD – standard deviation; Min – minimum; Me – median; Max – maximum.

Methods

The participants were asked to perform a medical procedure involving the preparation of a syringe with a drug administered by an infusion pump under 2 test conditions: 1 ATA corresponding to the atmospheric pressure only on land or on land and sea level, and 4 ATA corresponding to an underwater depth of 30 m. The order of test conditions was random. Both test conditions were performed inside a hyperbaric chamber.

The medical task for both pressure levels comprised of the same elements. When the participants performed the task, eye movements were recorded using a calibrated head-mounted video-oculography system. During both tests, the participants were in the hyperbaric chamber, directly at the workstation. Before starting the task, participants were required to familiarize themselves with the devices used in the study, which consisted of an eye tracker and the infusion pump used at the Clinical Department of Hyperbaric Medicine. All participants had experience in working with the infusion pump used in the study. To exclude communication errors, safety and communication procedures between the investigator and the participant were discussed prior to the study. The study was divided into 3 stages for each test condition to quantitatively assess the data collected.

Stage I: Preparation of the syringe with the drug – from the start of the task where the participant grasped the syringe until it was filled with the drug.

Stage II: Placing the syringe in the infusion pump – from the moment when the syringe was filled with the drug until the syringe together with the infusion tube were placed in the infusion pump by the participant.

Stage III: Setting the drug flow parameters – from the time the syringe was placed in the infusion pump to the start of the pre-set drug flow parameters expressed in milliliters per hour [mm/h].

A Therapeutic Barox HBO2 Omega chamber (Yaklaşım Makine, Istanbul, Turkey) equipped with 16 seats for HBO2 therapy, including a seat for a medical attendant, was used for the study. The maximum operating pressure of the Barox HBO2 Omega is 10 bar.

Right eye movements were recorded using a configurable oculography device (Pupil Labs GmbH, Berlin, Germany) measuring right eye movements at 120 Hz (up to a maximum of 200 Hz). The image from the ambient camera was sampled at 30 Hz. Eye movements were recorded to assess the level of distraction. The indicator of distraction was the ratio of eye fixations in the area of interest (AOI) to fixations outside this area. Data collection was performed using Pupil Capture Software v. 1.11.4 (Pupil Labs), with a sampling rate of 120 Hz and the camera image resolution 1280 × 720 pixels.

Data fragmentation and analysis were performed with software Mask AOI v. 1.5.1, developed by one of the authors in December 2019 for this research. Each fixation position was recorded and defined as being in/out of the AOI by using the point in polygon algorithm and coded as a binary variable where 0 or 1 meant fixation in or fixation out, respectively. Task completion time was measured as the number of video frames recorded from an ambient camera.

Statistical analyses

Statistical analyses were performed using Python 3.8 language packages: pingouin v0.3.5 (summary statistics), pymer4 v0.7.8 and rpy2 v3.4.5 (generalized linear mixed models (GLMM)). Figures were plotted in seaborn v0.11.2. The significance level was set at a $p < 0.05$.

The data were aggregated for each subject, ATA conditions and stage of the study. The time of completion was calculated as the number of frames for completion of each stage of the task. Fixations were coded as a binomial (0 and 1) variable as the presence or absence of fixations in the central field of view in each frame. The fixations were then analyzed for each of the stages in the study. To estimate the proper number of fixations in/out of the central view, we corrected the fixations by the number of frames and adjusted them for the number of frames due to the difference in the amount of time the participants required to complete each task. Therefore, we have set the completion time as weights. We chose the GLMM model, which allows the analysis of data in a structure that meets the aims of the study. Selected distributions for the completion time were the Poisson distribution and bimodal distribution with weights for the fixations, which corresponded to the characteristics of the dependent variables, as the completion time is composed of numbers starting with 0 and occurring at specific intervals (imposed by the recording resolution), and the fixations are coded as a binomial variable, aggregated and corrected by the number of frames (Python code is included in the Supplementary materials).

Model selection

Due to the lack of normality in both completion time and fixations ($p < 0.05$ for each condition using the Shapiro–Wilk test) and nested nature of repeated measures (1 ATA: stages 1, 2 and 3; 4 ATA: stages 1, 2 and 3), GLMM was used with the individual number of each participant as a random effect, and ATA value and stage as fixed (within) effects. Moreover, in the case of analyzing completion time, GLMM was analyzed using the Poisson distribution model for completion time and underweighted binomial distribution for the fraction of fixations in AOI over all fixations. Outliers have not been removed as there were no apparent effects on residuals during model diagnostics. To test the goodness-of-fit (Akaike criterion (AIC)), we compared 5 models: 1) only with intercept; 2) with the stage as a coefficient; 3) with ATA value as a coefficient; 4) with ATA value and stage without interaction effect; and 5) ATA value, stage and the interaction effect.

The goodness-of-fit test showed that there were differences in fixations in/out of the AOI (each $p < 0.001$) between model 1 (fixations AIC = 6706) and model 2 (fixations AIC = 6049), model 3 (fixations AIC = 7855), model 4 (fixations AIC = 6041) and model 5 (fixations AIC = 5732). In the completion time, only model 2 (time AIC = 4597) and model 5 (time AIC = 4565) differed significantly from model 1. However, model 5 (with both coefficients and interaction effects) has the lowest AIC for both fixations and completion time and was selected for the analysis. Model diagnostics showed that the residuals are approaching normal distribution, and despite the occurrence of some deviations, the model did not need to be changed due to the resistance of the GLMM to deviations from the normal distribution. More information on the model testing is presented in Fig. 1,2 and in the Supplementary materials.

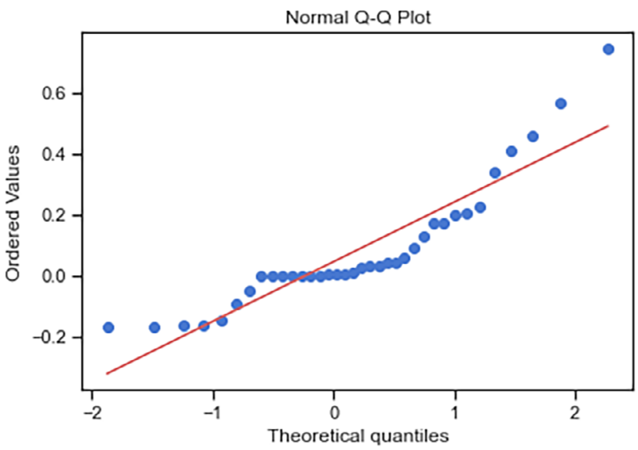

Fig. 1. Diagnostic normal Q-Q plot for the generalized linear mixed models (GLMM) model with fixations as a dependent variable (red line – normal distribution, points – model residuals)

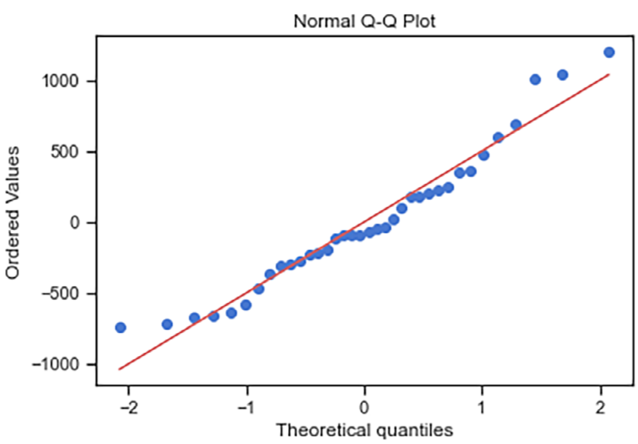

Fig. 2. Diagnostic normal Q-Q plot for generalized linear mixed models (GLMM) model with the completion time as a dependent variable (red line – normal distribution, points – model residuals)

Results

The distributions of the fixations (ratio) and the completion time based on chosen coefficients are presented in Fig. 3.

Task completion time

The camera image was recorded at a resolution of 30 Hz with a median of frames (Me = 2036.5, 1st quartile (Q1) = 1592.75, 3rd quartile (Q3) = 2718.25) within 67.8 s. The longest part of the task was stage 3 when the participants set the drug flow parameters (Me = 2202, Q1 = 1832, Q3 = 3231). The task was on average 78.38 frames longer under 4 ATA, but the median for 4 ATA was lower (1 ATA Me = 2114, Q1 = 1643, Q3 = 3146; 4 ATA Me = 1927, Q1 = 1502, Q3 = 2855).

The task completion time differed between the participants depending on testing conditions (ATA) and stage of task completion. The GLMM model showed that both the conditions (1 ATA and 4 ATA) and stages (1, 2 and 3), were statistically significant predictors of task completion times ($p < 0.001$). The 4 ATA conditions resulted in slightly more time required to complete the task than 1 ATA conditions, and stages 2 and 3 had longer completion times than stage 1. However, although there were differences in the means, they were not commensurate with the differences in the median (1 ATA compared to 4 ATA: Me = 2114 compared to 1927, Q1 = 1643 compared to 1502, Q3 = 3146 compared to 2855). In 4 ATA, stage 2 did not differ from stage 1 ($p = 0.172$), but stage 3 did (Table 2). The analysis used 95% confidence intervals (95% CI).

Table 2 presents the GLMM model with Poisson distribution of the task completion times measured as the number of frames during the completion of the task in each condition.

Analysis of attentional processes

The number of fixations in the AOI varied between stages (1, 2 and 3) and task conditions (1 ATA and 4 ATA), with lower values for the 4 ATA conditions. Under 1 ATA, the mean ratio of eye fixations in the AOI was 0.20 (Me = 0.066, Q1 = 0.013, Q4 = 0.361) as compared to only a 0.6 ratio under ATA 4 (Me = 0.003, Q1 = 0, Q4 =0.036).

The GLMM with weighted binomial link function showed that both the test conditions (ATA) and the test stages (1, 2 and 3) were statistically significant predictors of the fraction of fixations in the region of interest. Furthermore, increases in ATA value decreased the chance of directing eyes on the region of interest (OR = 0.659; 95% CI: 0.607–0.716). On the other hand, during stages 2 and 3, the chance of fixing eyesight on the region of interest increased compared to stage 1 (Table 3).

GLMM post hoc comparisons

Post hoc analysis with the Bonferroni correction was used to test the hypotheses about the influence of predictors (ATA value: 1 and 4; stages: 1, 2 and 3) on the dependent variables (fixations and completion time). Tests showed statistically significant differences between almost all testing

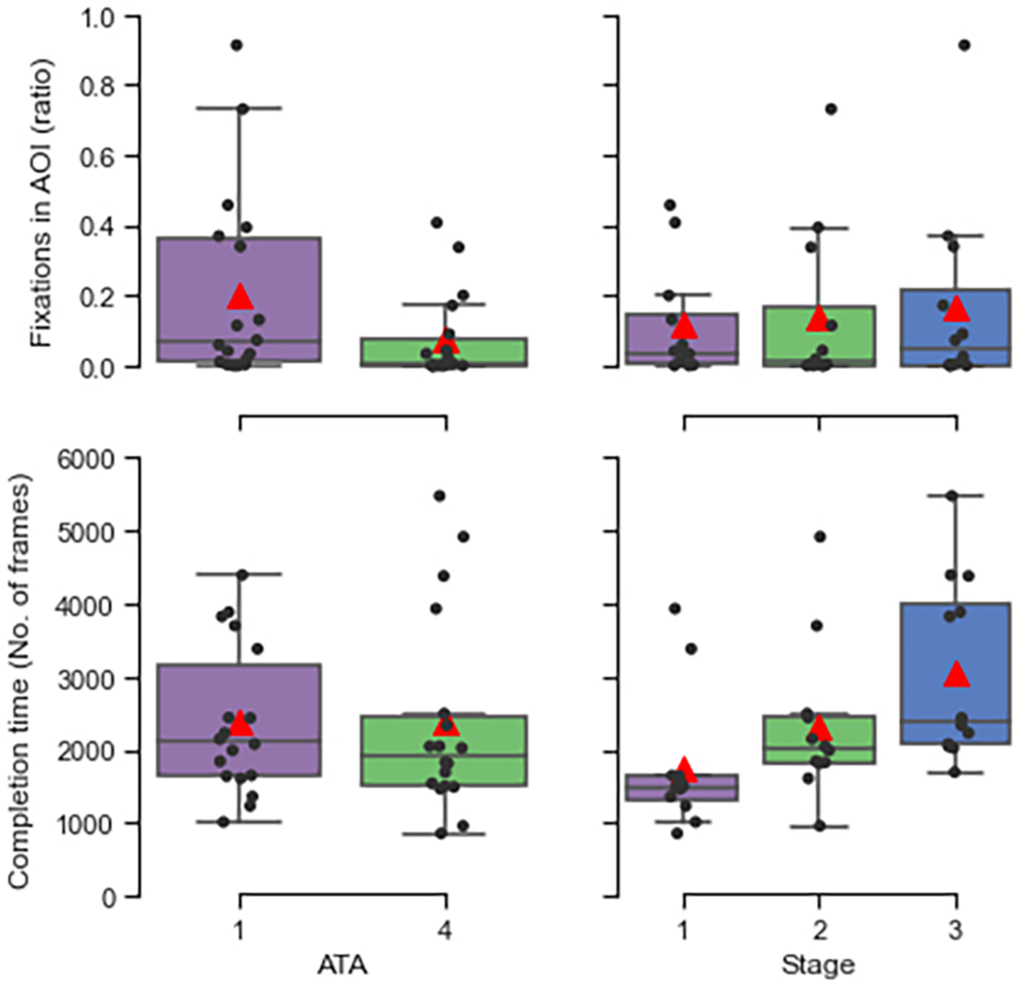

Fig. 3. Distribution of fixation ratios and the completion times depend on ATA value (1 and 4) and stages (1, 2 and 3). Fixations were measured as a fraction of fixations on the area of interest (AOI) from all fixations in each condition; the completion time was measured as the number of frames in each condition. Boxes represent 1st quartile (Q1) and 3rd quartile (Q3), black line represents the median (Me), whiskers represent values outside the middle 50% from minimum (lower whisker) to maximum (upper whisker), and the red triangle represents the mean (M)

Table 2. Generalized linear mixed models (GLMM) model with Poisson distribution of the tasks completion time measured as the number of frames during completing the task in each condition. One absolute atmosphere (1 ATA) and stage 1 were taken as an intercept; therefore, the coefficients were coded as factors, 4 ATA was compared to 1 ATA, and stages 2 and 3 to stage 1

Coefficients	β	CI 2.5%	CI 97.5%	SE	p-value
Intercept	7.393	7.145	7.640	0.127	<0.0001
4 ATA	0.049	0.022	0.076	0.014	0.0004
Stage 2	0.289	0.264	0.315	0.013	<0.0001
Stage 3	0.606	0.582	0.630	0.012	<0.0001
4 ATA × stage 2	−0.025	−0.061	0.011	0.018	0.172
4 ATA × stage 3	−0.097	−0.131	−0.063	0.017	<0.001

β – standardized beta for coefficient; CI – confidence interval; SE – standard error.

Table 3. Generalized linear mixed models (GLMM) model with weighted binomial distribution of the fraction of fixation in the region of interest in relation to all fixations in each condition. One absolute atmosphere (1 ATA) 1 and stage 1 were taken as an intercept; therefore, the coefficients were coded as factors, 4 ATA was compared to 1 ATA, and stages 2 and 3 to stage 1

Coefficients	β	OR	CI 2.5%	CI 97.5%	SE	p-value
Intercept	−2.086	0.124	0.040	0.380	0.482	<0.001
ATA 4	−0.417	0.659	0.607	0.716	0.042	<0.001
Stage 2	0.388	1.474	1.316	1.648	0.057	<0.001
Stage 3	0.553	1.739	1.585	1.908	0.047	<0.001
ATA 4 × stage 2	−1.303	0.272	0.218	0.336	0.110	<0.001
ATA 4 × stage 3	−1.404	0.246	0.203	0.296	0.010	<0.001

β – standardized beta for coefficient; OR – odds ratio; CI – confidence interval; SE – standard error.

conditions, with the biggest difference (Z score = −8.952, 95% CI: −0.178––0.09, SE = 0.015, p = 0.0067) for the differences during stage 1 under 1 ATA compared to 4 ATA for completion time, except comparisons in stage 2 compared to stage 3 in ATA 1 (Z score = −0.165, 95% CI: −0.341–0.0104, SE = 0.0599, p = 0.086) and under 4 ATA (Z score = −0.065, 95% CI: −0.412–0.283, SE = 0.015, p > 0.999) in fixations and stage 2 under 1 ATA compared to 4 ATA (Z score = 0.108, 95% CI: −0.059, 0.156, SE = 0.024, p = 0.717) for completion time (Fig. 4).

The participants were more likely to fix their eyes away from the AOI (fixations in AOI ratio: M = 0.139, SD = 0.226, Q1 = 0.0004, Me = 0.029, Q3 = 0.182), but more fixations in the AOI were recorded at the final stage of the test under 1 ATA (fixations in AOI ratio: M = 0.283, SD = 0.349, Me = 0.206, Q1 = 0.02, Q3 = 0.36), while the least were recorded at stages 2 (fixations in AOI ratio: M = 0.064, SD = 0.135, Me = 0.002, Q1 = 0, Q3 = 0.033) and 3 (fixations in AOI ratio: M = 0.008, SD = 0.012, Me = 0.003, Q1 = 0, Q3 = 0.01) under 4 ATA.

There was no significant difference between 1 ATA and 4 ATA conditions (Z = 1.560, 95% CI: −0.005–0.042, SE = 0.012, p = 0.253), but comparisons within each stage showed differences in each of them between 1 ATA and 4 ATA conditions (stage 1: M difference = −0.049, p < 0.001; stage 2: M difference = −0.024, p = 0.048; stage 3: M difference = −0.048, p < 0.0001).

Completion time significance was as follows: stage 1 under 1 ATA compared to 4 ATA: p = 0.0067, stage 2 compared to stage 3 under 1 ATA: p = 0.086, stage 2 compared to stage 3 under 4 ATA: p > 0.999, other comparisons: p < 0.001 The fixation significance was as follows: stage 2 under 1 ATA compared to 4 ATA: p = 0.717, other comparisons : p < 0.001.

Post hoc comparisons are presented in Fig. 4.

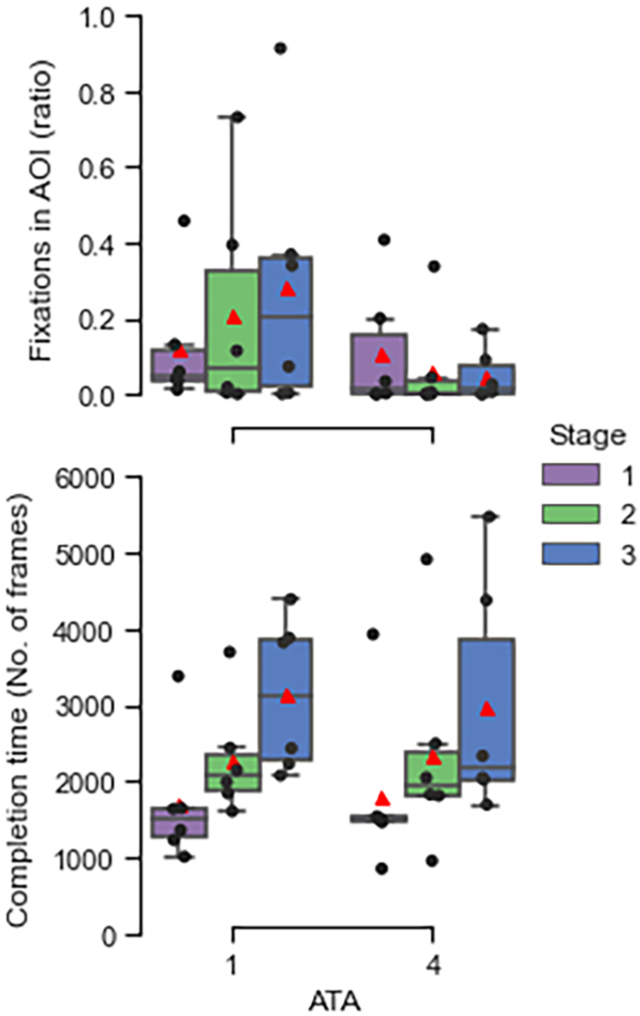

Fig. 4. Post hoc comparisons with Bonferroni correction of the fixation ratios and the completion times. Fixations were measured as a fraction of fixations in are of interest (AOI) from all fixations in each condition (1 ATA: stage 1, 2, or 3; 4 ATA: stage 1, 2 or 3); the completion time was measured as the number of frames in each condition. Boxes represent 1st quartile (Q1) and 3rd quartile (Q3), black line represents the median (Me), whiskers represent values outside the middle 50% from minimum (lower whisker) to maximum (upper whisker), and the red triangle represents the mean (M)

Discussion

The influence of the environment on human behavior is subject to analysis and monitoring at many levels of social activity.[8,9] Particular attention is given to those conditions that are obviously not the natural environment of humans, and which have emerged with the progress of civilization. A common goal of such measures is to minimize the risk. The dynamic development of technology over the last 100 years and the ever-increasing automation, the main purpose of which is to increase productivity, has not removed man from the position of the last decision-making link.[10,11]

Available studies devoted to the problem of professional activities in a pressurized atmosphere mostly refer to the work performed by divers.[12,13] Work in open water and a pressure chamber seem to bear some physical similarities – for example, in both conditions, the increase in pressure of the environment causes an increase in respiratory effort and the toxicity of respiratory gases. Under both conditions, nitrogen is of key importance and is responsible for the development of nitrogen narcosis. Working in open water and a hyperbaric chamber differ mainly in the number of environmental distractors, which can affect the professional operator in different ways. Staying underwater involves exposure to a range of stress-activating stimuli with physical and psychological vectors. Physical stimuli include changes in physicochemical parameters of respiratory gases, space, visibility, and finally, breathing performed with the use of a breathing apparatus.[14] Hypothermia is an important aspect for the cognitive functioning of a diver. Body heat loss is dependent on the form of protection and the duration of exposure to the surrounding environment. The cumulative impact of stress-inducing stimuli has a detrimental effect on the diver's nervous system capacity and compromises their performance.[15] During therapeutic sessions in pressure chambers, medical personnel together with the patient are subjected, as during diving, to the physical process of compression to the required pressure value, as predetermined in the therapeutic protocol. In our study, we did not record the temperature inside the pressure chamber during the compression of participants to the test conditions of 4 ATA. However, the increase in temperature inside the hyperbaric chamber during this procedure was a subjective feeling reported by each participant. The breathing process in pressure chambers takes place in a gaseous environment. Therefore, patients and the medical staff do not use any breathing devices. Hazards due to visual disturbances do not occur in a therapeutic pressure chamber. Due to patient-oriented environmental conditions, accidental hypothermia does not pose a significant risk to medical staff or patients inside the pressure chamber during a therapy session. Increased ambient absolute pressure and limited space are the main factors potentially adversely affecting a person inside the chamber. The common denominator for the described living environments is the physicochemical changes in the respiratory gases induced by physical changes in the environment and the performance of activities requiring high cognitive performance in an unnatural environment or limited space.

A study conducted in a pressure chamber by Łaszczyńska et al. using the eye-tracking technique revealed a deterioration in the ability of the cohort of divers assessed in the context of performing operator-like activities in simulated diving conditions at depths of 30 m and 50 m. The authors also showed that, based on eye–hand coordination tests, there was a significant increase in the number of errors made by participants under 4 ATA conditions. In the case of exposure to 2 ATA, the effect of "gaining practice" in the given activities appeared in the subjects. The time of saccadic eye movements was also assessed but without separation of gaze fixation in and out of the AOI.[16] Despite the different methods of assessing eye movements, the results obtained in the present paper and in the described study seem to converge. Cognitive improvement with decreasing ambient pressure should be considered the point of convergence here. Taking advantage of the different possibilities of assessing saccadic eye movements during performed activities, we decided to select areas of visual interest at each stage of the test. According to experts, the identification of AOIs in eye-tracking studies carries certain risks (for example risk associated with the selection of specific test conditions) for the obtained measurement results.[17] However, due to the fact that our study had the same test conditions for each measurement and was conducted on a group of experts, i.e., medical professionals, we eliminated the risk raised in the literature related to the lack of precise location of AOI in the environment observed by the researcher, if only by narrowing the operator space for the task performed. Blake et al. investigated the effects of working in hyperbaric therapy chambers on the attentional skills of staff using the Trail Making Test-A (TMT-A). Their study was conducted in a group of 28 volunteers who were either medical professionals or candidates to work in a hyperbaric facility. The test was conducted under 1 ATA, 1.8 ATA and 3 ATA conditions. The time during which the participants performed the task assessed using the TMT-A was considered a predictor at each stage of the study. No statistically significant differences were found regarding the time required for subjects to complete the TMT-A in 1.8 ATA and 3 ATA conditions. After completing the task, the participants noted that they experienced anxiety and some degree of fogginess while under 3 ATA. This suggests that visual testing methods may not be sensitive enough to assess the effects of elevated atmospheric pressure on cognitive functions.[18] In our study, we attempted to assess the level of attentional focus only during the performance of medical tasks in a real-time setting. In our opinion, oculography is a good tool that offers such technical possibilities.

Studies on the influence of elevated atmospheric pressure on human cognitive functions published in medical literature emphasize the importance of nitrogen necrosis. The necrotic properties of nitrogen in humans are revealed when the partial pressure of this gas increases. A depth of 30 meters underwater (muw) is considered to be the point of development of nitrogen necrosis, beyond which the risk of developing nitrogen narcosis increases significantly. At shallower depths, the occurrence of nitrogen necrosis is symptomatically similar to alcohol intoxication and poses a threat to the life of the diver.[19] Karakaya et al. in their study involving the assessment of recorded EEG potentials collected in a hyperbaric chamber under 3 study conditions (pre-dive, deep-dive and post-dive) observed that nitrogen necrosis caused mild and moderate impairment of cognitive functions among air recreational scuba divers at a pressure of 5 ATA. Cognitive impairment was also registered after decompression.[20] We did not examine the full spectrum of cognitive functions in our study, but focused on assessing the function of attention. However, for safety reasons, the protocol of our study included assessment for the development of behavioral symptoms of nitrogen necrosis in participants. We did not observe any overt symptoms of nitrogen narcosis. Although most medical procedures in hyperbaric chambers are performed under the conditions of 2–3 ATA, there are disease entities (e.g., gas embolism and decompression sickness) where the value of 3 ATA is exceeded. It is for this reason we evaluated the effects of elevated atmospheric pressure equal to or greater than 3 ATA on the attention function of medical personnel. In the future, this research may have a significant impact on improving the safety and quality of care for patients requiring hyperbaric therapy.

Limitations

The main limitation of the study was the small size of the cohort. It resulted from technical and logistical dependencies. The study was carried out in a therapeutic hyperbaric chamber, and the technical aspect of calibrating the eye tracker through the vision window of the chamber turned out to be a big problem. Calibration of the eye tracker took place before the start of the individual test and took longer than the test protocol provided for, which potentially affected the amount of data obtained.

Conclusions

The results we obtained and the test methods are supported by scientific literature. The assessment of eye movements using eye-tracking under hyperbaric chamber conditions was challenging due to its unprecedented nature in logistical and technical terms. Due to the results obtained in this study, we intend to continue further work on the effects of elevated atmospheric pressure on simple cognitive functions in medical personnel.

Supplementary materials

The Supplementary materials are available at https://doi.org/10.5281/zenodo.8234186. The package contains the following files:

Supplementary File 1. Python code with comparisons between models, chosen model results, diagnostics, and visualizations.

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