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ENVIRONMENTAL INFLUENCE ON DIVERS' HEALTH

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Abstract: *In contemporary society we all are deeply affected by the air we breathe, the water we drink, the food we eat, and, not in the least, along with other factors, by the stress we encounter in our everyday life.Apart from this general issue this paper aims to raise awareness on a specific problem concerning divers life and training, namely on how the environment can affect their health. The clinical and statistical studies observed the incidence of pathological changes that occur in people exposed to hyperbaric environment, which more often than not can be the case of professional divers. What we also aim at is to find solutions for the elimination and avoidance of such risk factors.*

Keywords: hyperbaric environment, pathological changes, breathing gas mixture, water

1. Introduction

The hyperbaric environment, hostile to human being, has been offering a multitude of new challenges, often extreme ones, to the underwater worker's body. The theme brings to debate issues that can influence the health of professional divers and supports the development of very strict rules, which influence the long-term health of the underwater worker.

Accordingly, based on the aforementioned assumptions, the objectives and work plan of the study were set, and the requirements for each objective and statistical studies for each selected parameter were done. Finally a database has been set, new conclusions for each specialty have been drawn, results obtained have been disseminated, especially for the professional divers, and further steps have been taken for the future development of the present study theme.

During the more than 40 years of existence of the military divers groups it has been noticed that the divers' health is pretty much affected by strain and fatigue. The entire body is affected, but the optimal functioning of the spine is also highly altered. All these may have different causes: overweight, type and weight of the equipment used in diving to provide the underwater breathing gas mixture, the low temperature of the underwater or simulator environment, etc, and by the shock the divers feel while they jump into water. The divers' diet, if not correlated with the daily physical effort, leads to overweight which in turn, may have an adverse effect on the body of professional divers, in general, and on their cardiovascular, bone and muscular systems, in particular.

Water (which has also been the subject of this study) occupies an important place on the hierarchy of human existence, along with the breathing gas used by professional divers. In the last years the research team of the Diving Center has been preoccupied with the quality of the natural and synthetic gas mixtures (binary, ternary, etc.) used in professional diving.

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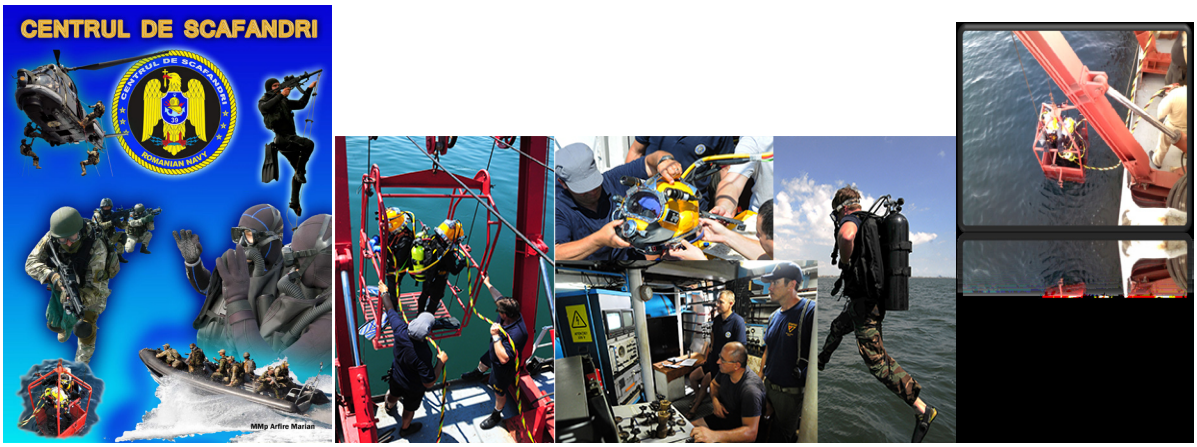

Figure 1: The divers groups at work

2. The Purpose of the Study, Hypotheses, Objectives and Studied Parameters

The purpose of the study is to highlight the health troubles that may occur to professional divers in order to prevent or improve their quality of work and their lives.

2.1. Hypotheses

- Forming a military or civilian professional diver requires a long time span (3 ÷ 7 years) during which the periods of time in which there is sustained effort alternate with the inactive ones;
- The type and the purity of the respiratory mixture used for diving;
- The lack of exercise, the food ration incorrectly related to their effort lead to the appearance of overweight (from the underweight / normal weight status one can easily reach the overweight one);
- The quantitative and qualitative consumption of water for hydrating the body – one has to pay attention to fluids which are non-tolerated by the body or toxic;
- The water as the working medium (the water in the pool, simulator or sea) can affect: the visual analyzer (conjunctivitis or blepharitis), the middle and inner ear, the eardrum (cracked) etc.
- The working environment – infested with impurities, bacteria, heavy and radioactive metals, hydrocarbons, etc. – may have high and low temperature, high and incorrect balanced pressure.

Figure 2: Moments during the measurements performed inside at Pier Zero of Port of Constanta

2.2. The Scientific Objectives

The target objectives were: observing the effects of the hyperbaric dry and wet environment on the human body for the purpose of knowledge of the risk factors that lead to their appearance and finding solutions in order to prevent them; elaborating the existent database on specialties, warning the divers on maintaining a balance between effort and consumption; drawing up specific regulations continuously correlated with those in the world's states which have a prestigious activity in the hyperbaric field.

2.3. Work plan

Our team's work plan was:

- Deciding on the group of divers involved in the hereby study;
- Deciding on an agreement regarding the participation in the study and in the elaboration of the database;
- Design and implementing of a questionnaire on the established thematic which was elaborated by the project's team, consisting of researchers, doctors, divers, etc.;
- Filling in questionnaires specific to each specialties;
- Sampling;
- Statistical processing of data;
- Conclusions;
- Elaborating future study directions.

2.4. The studied parameters

The studied parameters were: the hydrostatic pressure exerted by the hyperbaric environment, the temperature in the working environment, its pollution with various contaminants, the type of the gaseous mixture, the weight of the diver's equipment, ways of entering the water, etc.

All work is based on diving groups as such we felt it necessary to give a brief explanation of the significance of these groups. In this dive groups are:

- diving group I represent candidates and students divers;
- diving group II represent combat divers;
- diving group III represent deep-sea divers;
- diving group IV represent autonomous board scuba divers;
- diving group V represent heavy divers;
- diving group VI special workers (working in caissons or turrets);
- diving group VII represent employed personnel on all categories of submarines;
- diving group VIII represent specialized technical personnel of all categories: engineers, technicians, doctors, nurses, skilled workers etc. [1]

3. Improving the quality of breathing gas mixtures used in the diving activities

The research team of the Diving Center has been continuously preoccupied by the quality of natural and synthetic gas mixture (binary or ternary) used in professional diving.

The breathing mixture may be natural, i.e. air or synthetic. Synthetic mixtures are over oxygenated gas mixtures of binary type (NITROX or HELIOX) or ternary type (TRIMIX). When using these types of gas a few parameters should be taken into consideration: the depth of the work site, type of immersion (unit or system – in saturation) and the type of breathing device used (open circuit, semi-closed or closed circuit). All these factors determine the quality of the breathing apparatus used.

The study started from the contamination limits imposed by the standards of NATO countries such as France, Germany, Belgium, Italy, Denmark, etc., with reference to air (natural mixture breathed while working underwater) or to pure gases such as nitrogen, oxygen or helium and synthetic over oxygenated binary and ternary mixtures of these gases used for breathing in the process of immersion.

Possible sources of pollution with contaminants and their causes had been taken into consideration; finally solutions were found for improving the quality of gases used in diving.

We initiated our study starting from the divers' complaints about the quality of the breathing mixture. When going as deep as less than 55 meters divers felt discomfort due to the low temperature of the air breathed. Another observation was linked to the diver's unpleasant feel on their palate. The purity of the breathing gases was checked with gas analyzers and found that some problems were due the intensively used compressors; a few were fixed while others were replaced with new and more efficient ones. Further on, only gases with purity standards required by NATO were purchased. For nitrogen Germany, Spain, and England require a purity of 99.5 %, while Canada requires a purity of 99.9 %. Our center purchased nitrogen 4.8 which has (as described in the product catalog and extracts from SEAP) a

purity of 99.998 %. For pure oxygen the acquisition of medical oxygen was suggested (at a double price as compared to that achieved by our center at some point).
In order for the breathing mixture not to have a low temperature it was forbidden to store the gas cylinders on snow or ice for more than five minutes, and it was recommended that they be left in the bus or truck that brought them to the diving site. The gas cylinders were rigorously tested and if any degradation was observed problem was either removed by sandblasting, or the cylinders were replaced with new ones.
A few problems reported by divers were solved by purchasing new and modern gas analyzers, compressors and cylinders in accordance with the current standards, thus eliminating some of the problems raised by our fellow divers.
Strict operating procedures were set in accordance with the latest studies in the field, for each breathing apparatus.
Both the contamination limits and the contaminating substances are more strictly monitored aiming at the safety of work in hyperbaric environment.

4. Water

Apart from the breathing gases and the food, water plays an important part in the life of professional divers.

4.1. Water - working environment

Water as a working environment - exerts a hydrostatic pressure on divers' body both during compression and during decompression, i. e. going deep underwater and up to the surface. Water exerts a high pressure on the divers' organs mostly on the respiratory system and abdominal organs. The hydrostatic pressure can cause a lot of accidents mainly during decompression, if this is not properly controlled.
The degree of water and other marine ecosystems pollution with various pollutants may have a harmful action on the divers' body.
The study showed that pollution of water with metals can harm human body. Radioactive pollution of waters, beaches and sea beds and its action on divers was another major issue studied.
Other issues concerned the microbiological pollution of sea water and its action on the human body, along with the infectious agents, and zoo-noses due to marine organisms.
Another parameter of the working environment was temperature. Divers' exposure to low temperatures and their effects on the body was also tackled. Finally, measures to prevent hypothermia and first aid in case of hypothermia were mentioned.

4.2. Hydration water

Water used for hydration – the water consumption is closely related to intellectual or physical fatigue, headaches etc. The body's deliberate or unconscious dehydration can cause stomach pain, joint pain (cartilages have a high proportion of water) or may affect the bone system.
People can have major problems due to insufficient water consumption. It is recommended to drink at least 2 litres of water per day. The actual water consumption for a person in 24 hours is generally much lower. Thirst often occurs later and entails many unpleasant sensations in a healthy body. It was found that the shortage of water in the body can cause major inconvenience and the fact that with age the thirst sensation decreases even more, leading to skin aging (an immediately visible effect).
We have studied the main types of mineral water in Romania. All characteristics that appear on the labels of the bottles have been tabulated deciding, based on the structure of their contained elements, the opportunity of their acquisition. The hereby subchapter highlights the need, in fact the obligation, of water consumption during missions and real or simulated training, water delivered by means of norms depending on the number of diving hours and on the hot or cold liquids the diver has in the daily norm (tea, coffee, milk, broth, soup, sauce, compote etc.)
In conclusion the awareness of the water

need concerning the diver's body is directly related to the conditions, under which he operates – the hyperbaric environment, respectively the arid area of the coast, the effort in the marine environment and so on leading to severe dehydration of his body, dehydration mainly caused because of his sustained effort.

5. Protecting the working environment

One factor that may adversely affect the divers' health is the pollution of the underwater environment.

In order to bring added health to the underwater worker, the followings were imposed: a strict cleanliness around ships, piers and dams, where divers work permanently. Depending on the aquatory hydrodynamic type, on the chemical properties of the water body and on their dynamics, on the industrialization degree of seawater, on the pollutants producing sources (pollutants are very diverse and extremely toxic in the port waters) and on the means in which the compounds enter the underwater ecosystem, the concentrations of pollutants vary a lot within the marine environment.

As a result of the conducted research, an increase in the water temperature was noticed – from the value of 10°C to the value of 30°C. In this way we can observe that this process influences the appearance of heavy metals toxicity (mercury, cadmium, chromium, zinc, nickel), or the action of hydrocarbons on biotic components of marine ecosystems, environment in which the divers of the military base mainly operate. We must not forget the polluting effects of synthetic materials and non-degradable plastics, of organosilicon compounds or those of pesticides, for example those coming from the water discharged by wastewater treatment plants whose waste water filters do not have the power to purify; all these affect the underwater environment and hence the divers. Another observable aspect is represented by the underground storage of toxic substances, which under the influence of marine phenomena and processes migrate to the surface with an average speed of 5 m / year.

During the time span of the present study, we have also done research on the effect of the chlorine concentration in the swimming pool water upon the divers' eye; a lot of measurements have been carried out in this way. Their results are included in an extensive study performed by the CPSA Laboratory experts of the Center and have been registered in the project's database.

In conclusion the particularly polluting agents present everywhere within the coastal waters or offshore, especially in port aquatories and swimming pools contact the divers' body, having an effectively negative influence upon their health.

6. Oto-rhino-laryngological (ORL) and opthalmological diseases

Aim of the study: clinical evaluation of the ORL pathology in professional divers.

Material and method: a number of 564 divers were examined in the ENT (ear, nose, and throat) section between January ÷ December 20xy. ENT disorders were spotted during diving which caused unsuitability for further practice of such an activity.

Statistical results obtained from investigations for different groups of divers:

At I group of divers we observed:

- acute respiratory disorders, of superior obstructive type, nasal septum deviation, hypertrophic rhinitis, in 20 % of subjects;
- chronic scarring otitis, and chronic fibro-adehesive, otitis, in 10 % of the examined divers.

At diving group II:

- neurosensory hypoacusia, in 10 % of the examined divers;
- transmission or mixed hearing loss and / or associated with higher obstructive respiratory disorders, in chronic condition, in 10 % of the examined divers.

Group III:

- 5 % of the examined divers showed neurosensory hypoacusia.

Group IV:

- 15 % had chronic media fiber-adhesive otitis associated with hypoacusia, or simply hypoacusia;
- 10 % of the examined divers showed neurosensory hypoacusia.

In conclusion it can be stated that group IV showed the most cases ENT disorders, followed by groups I and II. In the other groups no pathological changes were found after oto-rhino-laryngological examination. In the ENT sphere the following restrictions should be imposed:

- forbid diving in divers with ear infections, even to those under medical treatment since all these may lead to hearing deficiencies when combined with other hyperbaric factors;
- possess knowledge of methods to ensure permeability of the Eustachian tube (e.g. by deglutition method, the Frenzel method, the Valsalva maneuver etc.).

The diver who has been the victim of an accident implying barotrauma of the middle ear, may have symptoms such as hearing loss, tinnitus, ear pain, runny nose and mouth fluids, blood in nasal secretion and in the oral cavity, ruptured ear drum, etc.

Cold water eardrum rupture is potentially more serious. Cold water entering the middle ear causes violent damage to the sense of balance resulting in serious dizziness, vertigo and nausea.

Balance disorders may arise during going up to the water surface and are called alternobaric vertigo. This phenomenon occurs during ascent to the surface, especially after a descent with difficulty in equalizing the pressure in the middle ear. From the point of view of the eye we had in view the main ocular disorders occurring in divers depending on the group of diving and age. They are most often due to the water which is, by no means the diver's working environment.

We also had in view the following working parameters: the hydrostatic pressure exerted on the eye and the quality of the water contained in the pool, simulator, of the port and sea basin, etc. on the visual analyzer. As a result of the measurements made the main problems encountered were conjunctivitis and blepharitis.

Some divers show refractive errors. 12.42 % of the evaluated divers presented eye conditions including: 12.9 % acute ocular dysfunctions, 14.51 % had chronically disorders, and 72.5 % had disturbances due to the flaws of refraction. To prevent acute diseases of the visual analyzer it is necessary to take into account the following:

- the concentration of chlorine in the tanks should be 0.5 mg at a pH of 7.2 - 8.2;
-in 90 % of the samples taken from the basins every 3 months the number of bacteria on ml should be less than 300;
- in 90 % of the samples the coliforms will not exceed 10 / 100ml;
- in 95 % of the samples, Pseudomonas aeruginosa (the health indicator) should be 2/100 ml.

It was found that for the age group 19-30 the risk of eye damage is greater than of those of the same age who were not exposed to hyperbaric stress.

The incidence of ocular disorders was higher in diving groups VII, II, III.

There were variations in intraocular pressure over the maximum values.

Intraocular pressure should be monitored through ophthalmoscopies so as to track the changes that occur over time the people who work in hyperbaric environment, since these changes can lead to glaucoma. Most disorders of refraction, after a year from the optical correction, were met in the age group 30 ÷ 40, and in DG II, and IV.

The optimal air correction, or in correction with contact lenses lead to stabilization of refraction and / or may improve it significantly.

Establishing the correlation between the hyperbaric environment, the depth of immersion, the equipment used, and the physical effort of the diver emerged into a set of measures to be taken for, i. e. to check the level of chlorine in the pool water, to clean it weekly; to wear polarized glasses by the personnel of the diving area etc.).

Figure 3: Hiperbaric chamber

Figure 4: Moments during the measurements performed inside "Mircea cel Bătrân" Naval Academy, the Hyperbaric Laboratory of the Diving Center and at Pier Zero of Port of Constanta

The study envisaged the establishment of a database for the main eye diseases that can lead to a drastic weakening of sight. We had in view the effects of dry and wet hyperbaric environment on the visual analyzer, i.e. the eye, in order to know the risk factors that lead to them and finding solutions to their prevention, which we consider a fulfilled objective.

7. The operation mode, interpretations, discussions and measures adopted

Regarding the intake of calories there is a direct correlation with an individual's weight status (body mass index) and the biological status, it was concluded that regular daily intake of about ~6000 calories is inadequate. This ratio is given to the divers who have their meals at work, while there is another botch of divers who do not do this. The latter category's food is more adequate since it is served at home, where the intake of calories is lower the ~ 6200.

Caloric intake is high and inconsistent with the requirements of diver's physical activity, and normally varies from day to day and from one individual to another (more or less active, with a more active or lazy metabolism, younger or older, etc.). Food combination may often be quite "unhappy", i.e. indigestible a unhealthy, leading to negative evolution of biological weight status.

At the beginning of an study the situation of divers' diet was not one of the best, i. e. they were fed mostly on white bread, fried potatoes, roux and some sorts of additives that added taste but not quality to their food.
It was initially started from the analysis of all persons who received diving certificates and observed that:
- metabolic changes found were simple or mixed dyslipidemia, found in 30th divers,
- metabolic syndrome has a heterogeneous etiology that allows associating metabolic changes that occur in diabetes dyslipidemia, obesity and cardiovascular diseases,
- nutritionists believe that calorie food products rich in carbohydrates play an important role in metabolic syndrome.
Early identification and treatment of patients with metabolic syndrome prevention is the main strategy of both type 2 diabetes and cardiovascular disease.
Physical exercise, reduces central obesity, blood pressure, and has an important role in the management of metabolic syndrome.
The incidence of these health problems is presented below, separated on groups of divers:
I dive group - at a rate of 1.78 %;
Group II dive - at a rate of 12.74 %;
Group III diving - at 14.58 %;
Group IV dipping -at 1.42 %;
Group VII diving -at 12.19 %.
It has an increased incidence in DG III (14.58 %), II (12.74 %), VII (12.19 %)
Changes in body weight (overweight) ware met in according to 59 divers.
Diving groups, overweight was met in a number of:
- 7 divers with diving group (DG) I, a percentage of 6.25%;
- 24 divers with DG II, i.e. 23.52%;
- 4 divers with DG III, i.e. 8.33%;
- 18 divers with diving group IV, i.e 8.57%;
- 6 divers with DG VII, i. e. a rate of 14.63 %.
The highest incidence was in DG II (23.52 %), and DG VII (14.63 %).
The metabolic changes are a consequence of high calorie diets, and inadequate physical activity undertaken.
Even if the percentages may seem insignificant the high index of weight associated with changes in cardiovascular system are risk factors.
At digestive level of 512 divers, 6 were detected with HBsAg, i. e. that is 1.17 %.
They are evaluated clinical, in biologically and ultrasound every 6 months.
At the musculoskeletal level deficiencies were observed at the lumbar spine: back pain, lumbar intervertebral discopathy.
In DG II cases have been detected in advanced stage with lumbar discopathy, leading unfitness to dive.
Thus, we studied two groups of divers with 2 types of diet, i. e. family and community (at work, in the mess hall of the base).
We looked for similarities and differences between members of the two groups with regard to weight status represented by body mass index, biological status represented by cholesterol, triglycerides, liver transaminases, and level of physical activity performed daily and the calorie intake.
The first batch consists of 38 male professional divers who eat in family - at home, according to the daily needs of each.
The second group consists of 47 men, also professional divers, who eat at the canteen of the military unit where they work instead they have a daily ration (established by Rule 4) of ~ 6200 calories unrelated to their physical activity levels.
The distribution by age of the two professional divers' groups shows the predominance of young people (v. table 1, and figure 5):

Table 1 Structure by age

Age	Family	% of total family	Community	% of total community
20 ÷ 29 years	14	37	23	50
30 ÷ 39 years	23	60,5	18	38
40 ÷ 50 years	1	2,5	6	12

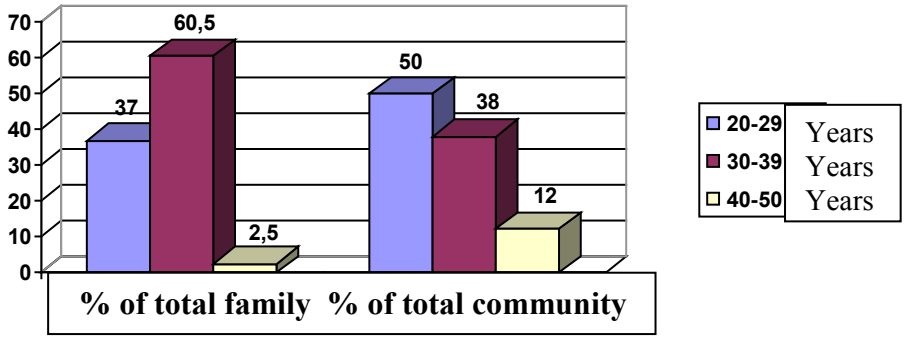

Figure 5: The distribution of the two groups of divers by age

It investigated the level of physical activity undertaken in the hours spent at work and was correlated with the type of food used, noting that most divers who have sustained physical activity eat at home.

Table 2 Structure by physical activity

Physical activity	Family	% of total family	Community	% of total community
Low	6	16	9	19
Average	0	0	28	60
High	32	84	10	21

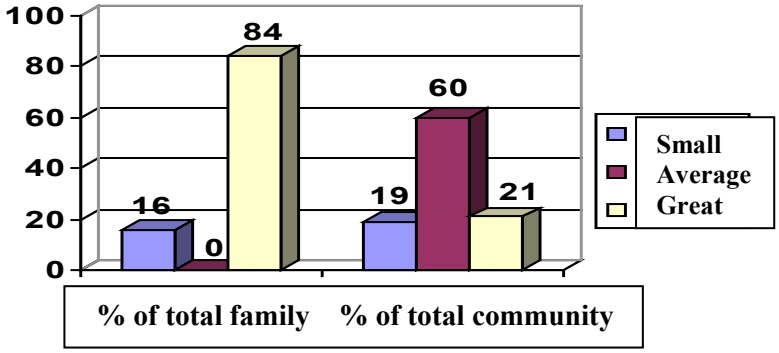

Figure 6: Distribution according to physical activity

Analyzing the biological status, particularly the lipid profile, dyslipidemia prevalence is observed at divers into an organized i. e. at the mess hall of the base work (community).

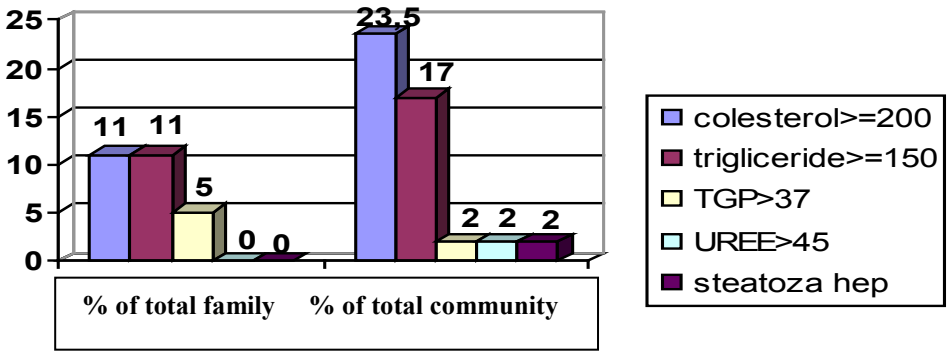

Figure 7: Dyslipidemia prevalence is observed at divers fed into community

It used body mass index as a means of interpreting the divers' weight status. Overweight divers comprising the obese and pre-obese people were found in

both groups (those eating at home and those eating at work); 19 % was the percentage representing the divers who eat at work and 5 % was the percentage of the divers eating at home.

Table 3 Structure by weight index

Weight index (IMC)	Family	% of total family	Community	% of total community
19 ÷ 25	36	95	38	81
26 ÷ 30	1	2,5	8	17
Over 30	1	2,5	1	2

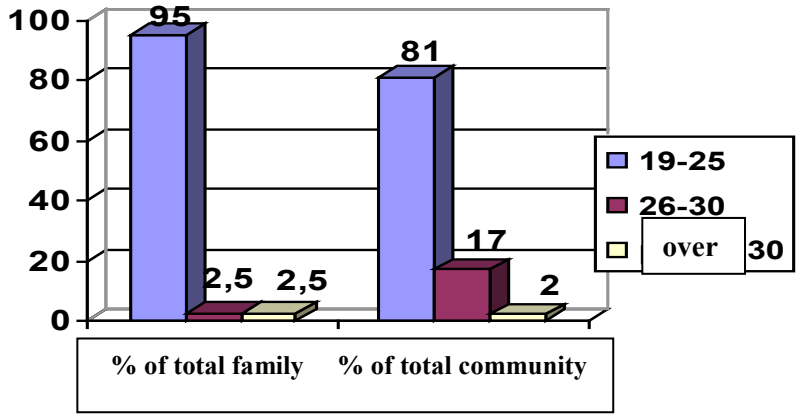

Figure 8: The distribution by weight index

Analyzing the overweight people in the two groups we found that there were more often met in young people, especially those who eat in community.

Body mass index of correlation with physical activity levels of overweight cannot distinguish a significant proportion report.

One of two overweight eaters in community is obese, has lower physical activity and shows changes in triglycerides and hepatic transaminases.

In conclusion net differences were observed between the two groups, indicating that the type of diet and weight status influence biological divers' health.

A diet too high in calories that is not consistent with daily needs (depending on physical activity) proves to lead to weight gain (pre-obesity and obesity) and changes in their cholesterol, triglycerides i. e. increasing values.

A daily intake of ~ 6200 calories is difficult to make from food made with healthy nutrients. Hence, the negative effects observed in this study.

The correlation between the diet assigned to divers eating in community and their daily physical effort, along with their diving activity should be investigated.

Although divers in the community may be knowledgeable about the principles of healthy eating, they do not always have the choice to eat healthy while the intake of ~6200 calories and calories in the diet will bring "negative" calories -fats, for example.

High pressure at the eye level was registered in divers.

Monitoring the eye pressure is mandatory since there have been observed changes in the hyperbaric workers eyesight; these changer to glaucoma.

The rectified diet applied to divers proves its effectiveness in responding largely to metabolic disorders.

We aim at:

- establishing procedures for monitoring caloric diet of divers, so they can be optimally maintained between diving effort and calories contained in their diet;
- establishing caloric rules effective in maintaining the health of underwater workers.

7.1. Interpretation and discussion after the first year of analysis of all persons who received diving certificates

These clinical studies have sought statistical incidence of pathological changes that occur in those exposed to hyperbaric environment in order to eliminate and avoid those risk factors that endanger the health of divers. Data show that after chronic exposure to gaseous mixtures can give rise to: arthritis, cardiovascular diseases, particularly of the heart muscle, optic nerve damage, paralysis, paresthesia. We proposed urgent measures to improve and to develop professional diver caloric diet, improving access to the swimming pool and Hyperbaric Simulator Laboratory establish a chlorine concentration of 0.5 mg of water at pH 7.2 ÷ 8.2 etc.

The study shows that a large percentage of divers noticed within a period of one calendar year (January to December) showed changes in cardiovascular, metabolic and digestive systems.

Cardiovascular changes occur at a rate of 53.95 % at metabolic rate of 42.32 % and 3.72 % at digestive level. The metabolic changes were more frequent in the divers group II and cardiovascular changes occurred at a higher incidence in DG III and II. They also reported arthritis with equal weight to DG II, III, and IV.

It has been found that in the age group 19-30 years the risk of damage to the eye is larger than in those of the same age that were not exposed to hyperbaric stress.

The incidence of ocular disorders was higher in the diving groups VII, II, III.

Most disorders the refraction, after a year from optical correction was met in the age category 30 ÷ 40 years, at DG II and IV.

A diet too high in calories that is not consistent with daily needs (depending on physical activity) proves to lead to weight gain (pre-obesity and obesity) and changes in the cholesterol, triglycerides that can go over normal values.

7.2. Conclusions

We found an increased incidence of changes in the cardiovascular system (53.95 %), at the metabolic level (42.32 %) and a small percentage of 3.72 % at the digestive tract.

Among the cardiovascular changes observed there were: right bundle branch block, left ventricular hypertrophy, and cardiac arrhythmias.

The incidence of cardiovascular damage was higher in diving groups III and II.

The metabolic changes have been more common in diving group II.

The presence of AgHBs detected in 6 divers requires careful monitoring of the clinical course.

No significant variations were found concerning the incidence of disease in the lumbar spine by diving group type. However, the most commonly reported were back pains.

A proper nutrition helps the body recover, maintain a high tone and keep a balanced mental condition.

Finally, health is maintained by correct, rational and balanced feeding.

8. Preventive measures against diseases caused by the interaction of the diver with the hyperbaric environment

Prevention of various diseases found in this study requires:

- compliance with the diving regulations;
- protection of the body with diving equipment according to the pollutants existing in the diving area;
- checking the concentration of chlorine in the training pool water (it must be max. 0.5 mg at a pH of 7.2 to 8.2) [5];
- providing additional staff for cleaning of tanks, the simulator has pressure chambers;
- specialized staff in charge with land and surface observation, the diving chiefs must wear polarized glasses;
- the number of bacteria / ml in 95 % of the water samples taken every three months, must be smaller than 300 [5];
- number of coliform bacteria in 90 % of the samples taken every three months must not be over 10 / 100ml [5];

- in 95 % of samples, Pseudomonas aeruginosa, the health indicator must be 2 / 100ml [5];
- in the case of acute eye conditions, under treatment there will be no diving operations indicated to the respective diver.

9. Final Conclusions

The promotion of science and systematic application of scientific research results on the techniques and technologies used in the diving activity modernization of existing equipment will have a beneficial effect on the interaction of underwater worker and hyperbaric environment.

This paper highlights the ways in which the staff of Diving Center disseminates the scientific studies results among professional divers by organizing / attending sessions, symposia, roundtables, workshops etc.

Diving Center promotes scientific and technical cooperation with interested institutions in the developing, on multiple fields, of research activities applicable to all types of diving.

10. Proposals for the future

The deeper we go into the trade of diving the more aware we become of the multitude of factors that can and will affect the health of professionals divers.

Based on this conclusion, the problems arising from the interaction diver-hyperbaric environment request the need for cooperation at various levels with specialists in related fields as well as researchers in scientific and technical branches and that go close to physics, chemistry, medicine, engineering etc.

The study opens multiple directions for further research on any type of diving and new devices used by professional divers, aiming to be an invitation to future interdisciplinary collaboration.

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Abbreviations and acronyms

ADH = antidiuretic hormone;
AgHBs = HBs antigen;
B = old/aged man;
bact = bacteria;
β = beta;
CMN = Navy Healthcare Center;
CO = vacation;
CPSA = Research and water plunging Laboratory;
DG = Diving Group;
Cursul PAS = Diving Training Course;
ENT = ear, nose, and throat;
EOD = Explosive Ordnance Disposal,
g = weight in kg;
h = height in cm;
HDL = high-density lipoprotein (popularly is known as good cholesterol);
LDL cholesterol = low-density lipoprotein (popular is called bad cholesterol)
LH = Hyperbaric Laboratory;
m = metre;
M = man;
MApN = Ministry of Defence;
MB = basal metabolism;
mg = milligram;
ml = millilitre;
NW = Normalweight;
ORL = otorhinolaryngology;
OZU = Daily Military Journal;
OW = Overweight;
SCAFS = Research Department, Advising and Training activities diving Diving;
SEAP = Electronic Procurement = Sistem Electronic de Achiziţii Publice (SEAP);
SMFN = Staff of the Navy;
s = second;
T = young man;
TNR = recommended nutritional tolerances
v = age in years;
W = woman.

Terms of strict specialty:

Unitary diving = instalment of the following operations: compression, effectively immersion work and decompression, it can be of two types: autonomous and of system;

Saturation diving = the immersion in which the divers' exposure to the ambient pressure, corresponding to the dive depth is long enough so that their body tissues could be fed with gas or inert gases in the breathing gas;

First diving group = candidates and students divers;

Second diving group = combat divers (EOD divers etc.) who dive using closed circuit oxygen diving apparatus at a depth of 7-12m and compressed air apparatus at a depth of 40 to maximum 60m;

Third diving group = deep-sea divers who carry out unitary diving up to 180m, with turret or midget submarine up to 300m or more. Unitary diving up to 180m and special equipment diving presenting saturation with synthetic breathing mixtures at depths of 300 - 600m;

Fourth diving group = autonomous board scuba divers carrying out diving helped by compressed air apparatus at 40-60m;

Fifth diving group = heavy divers carrying out diving helped by compressed air apparatus up to 40-60m;

Sixth diving group = special workers (working in caissons or turrets) who work in an atmosphere of compressed air at 4-6 bar;

Seventh diving group = employed personnel on all categories of submarines who acts as scuba divers when necessary;

Eighth diving group = specialized technical personnel of all categories: engineers, technicians, doctors, nurses, skilled workers etc. (People who, depending on their position, work permanently or temporarily in the hyperbaric field). [1]

References

[1] The technical standards and medical procedures regarding the medical-military expertise of the personnel who works in the hyperbaric field and on board Navy ships and the medical scale in order to determine suitability for diving and boarding the military staff and the civilian employees of the Navy - Romania, Ministry of National Defence, Navy Headquarters – Printing House of MApN – Constanţa 1991;

[2] Haward Hu, Frank E. Speizer, Environmental and professional risk factors, medical book, fifteenth part.

[3] Instructions for feeding the personnel belonging to the Ministry of National Defense during peacetime L – 4 / 1;

[4] Regulation on physical training – Bucureşti 1984

[5] Project: "Environmental influences on divers' health", Diving Center 2007;

[6] Training syllabus of Navy military divers – 1994.