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The Effect of Diving for Different Years on $CD34^+$ Stem Cells and Some Physiological Variables for Commercial Divers

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Abstract The current study set out to determine the effect of diving on several physiological variables and stem cells in commercial divers for various years. Twelve divers and six non-divers were divided into three groups: 11 non-divers (1st group), two divers with a diving history of 5-6 years (2nd group), and three divers with a diving history of 9-10 years (3rd group). Physiological measurements of pulse, blood pressure, dynamic breathing functions, stem cells $CD34^+$, and cortisol were performed before and after physical exertion during a day dive at a depth of 25-30 meters in the pressure room. The results showed a significant difference in pulse, blood pressure, stem cells, and cortisol, while no change in dynamic breathing functions after exertion. Further, diving for different years may positively affect biological changes of stem cells $CD34^+$ in the adaptation process but may harm dynamic breathing functions. Therefore, periodic lung function evaluation should be encouraged to check for potential harm to divers. In our conclusion, diving for different years may have a positive effect on biological changes of stem cells $CD34^+$ in the adaptation process, while a negative effect may be induced in a dynamic breathing function. Periodic lung function evaluation should be encouraged to monitor potential harm to the divers.

Keywords Diving, Physiological Variables, Stem Cells, $CD34^+$, Cortisol, Breathing Functions

1. Introduction

Diving is distinct from other water activities performed for various reasons, including recreational, commercial, scientific, or military purposes, and for discovering and studying marine sciences, geology, geography, and tourism, whether internal or external. Exposing the body to many risks and pressures of various fluids has a detrimental impact on all the different body systems, especially the internal ones [1-4].

Divers are subjected to many pressures on their bodies, which have a variety of physiological effects on all body systems, including the circulatory system, respiratory system, nervous system, muscular system, brain, and skeleton, and the greater the pressure on these devices, the greater the effects caused by diving [5-8].

The commercial diver must be one of the most skilled divers in all areas of diving because the work requires specialized expertise and equipment, as well as the ability to work at depths greater than those permitted in recreational diving, requiring special training and a specific type of divers with physical and physiological capabilities [9], [10].

Given the unique characteristics of commercial diving practitioners, such as long-distance diving for a prolonged time and significant physical activity exerted underwater during assigned work, several studies have been devoted to determining the physiological effects of long-term diamond diving. The majority of previous studies have always recommended conducting more research into the physiological changes that occur due to scuba diving for long periods [11], [12].

A healthy respiratory system is critical for athletes, especially divers, where any breathing resistance reduces the comfort of those working in the aquatic environment. Thus, it is important to evaluate lung function parameters such as FVC, FEV1, FEV1%, and PEF using the SPIROMETRIC test [13], [14], [15]. Accordingly, any deviations from the legally required qualifications for employment as a licensed diver are critical [16].

The research issue can be defined as determining the responses to certain physiological variables caused by physical work when exposed to underwater pressures and determining whether or not there is a difference in the magnitude of responses due to years of professional life in this field [17-22]. Changes in the diver's physiological state as a result of years of hard work and exposure to a variety of stresses are deemed important and worthy of further research and study to bring more useful information to sports physiology in general and deep physiology in particular [23], [24].

Objectives of the Study

The study aims to identify the effect of diving for different years on some physiological variables among commercial divers by achieving the followings: (i) identifying the impacts of physical work and exposure to stress during diving on certain physiological variables in three study groups: those who practiced commercial diving for 9-10 years, those who did not practice diving or any other sporting activity for 5-6 years, and those who did not practice diving or any other sporting activity for a period of (9: 10) years, and (ii) recognizing the type of relationship between the physiological variables under consideration and practicing commercial diving based on the years of professional life in this field.

2. Research Methodology

The researchers used the descriptive approach in conjunction with a survey method.

Research Community

The research community is represented by a group of commercial divers working in commercial diving in Egypt and accredited by the International Federation of Commercial Diving Contractors.

The Research Samples

The researchers have intentionally chosen the basic research sample from the commercial divers employed by the marine oil services company, PMS. The core sample and survey sample consisted of twelve divers, six non-divers or participants in some form of sports activity, and two divers from the same research community who were not included in the core sample, with a total of twenty individuals.

Means of Data Collection

Determining the Physiological Variables for this Study

Reference Survey

The researchers performed a reference survey on previous studies that addressed the physiological aspects of diving, including 13 Arab and 16) international studies, to ascertain the physiological and biochemical variables relevant to the research topic.

Determining the Variables for this Study

The researchers chose the following physiological and biochemical variables:

- Stem cells $CD34^+$
- Cortisol hormone
- Blood pressure
- The pulse
- Dynamic breathing functions

The Equipment and Tools Used in the Study

- Terameter for estimating the height
- Digital weight
- Sphygmomanometer for blood pressure
- Stethoscope
- Pulse meter for pulse rate
- Diving chamber
- Flow cytometry for estimating CD 34 t
- Three oxygen cylinders
- Syringes 5ml for collecting blood
- Tubes for blood samples with cups
- Icebox for blood storage
- Alcohol
- Cotton
- Camera
- Stopwatch
- Diving table / US Navy

- Gloves
- First aid box
- Spectrophotometer for cortisol estimation
- SPIROMETER for testing FVC, FEV1, FEV1%, and FEF

Survey Study

On 6/25/2019, the researchers performed a survey of a group of 2 commercial divers from the research community and individuals who are not included in the basic sample, in addition to the participation of all individuals from the basic and reserve research samples, to familiarise themselves with the procedures used to perform the basic analysis. The following are the most important measures considered in the first survey:

1. The assistants' understanding of the measurement methods and accuracy in recording with the;
2. Ensuring that the best conditions for conducting the measurements are established to obtain the best results.
3. Standardization and Validation of the measuring instruments and devices used in the research.
4. Ensuring the identification of the registration card used for the measurements
5. Understanding the basic research sample for basic study procedures

Basic Study

The basic analysis was conducted on the research sample on 7/17/2019, in a room designated for abstinence in the diving department of the Arab Academy for Science, Technology, and Maritime Transport in Alexandria, in two phases, as follows:

- The first stage (pre-measurement):

Physiological measurements (e.g., pulse, systolic, and diastolic blood pressure), blood sample analyses (e.g., stem cells CD34 +, cortisol), and dynamic breathing functions were performed.

- The second stage (telemetry):

After conducting physical exertion during a dry dive at a depth of 25 meters and a period of 22 minutes using the US Navy's special diving schedules to assess the maximum time limit for this depth, measurements of pulse, systolic, and diastolic blood pressure, and dynamic breathing functions were taken. Blood samples for $CD34^+$ stem cells and cortisol were then withdrawn.

- Statistical treatment plan:

The data were statistically processed using the SPSS statistical program for the following statistical equations:

- SMA
- Distortion coefficient
- Standard deviation
- T-test to calculate the significance of the statistical differences in the – groups
- ANOVA variance analysis to calculate differences between groups
- Tukey test to calculate the trend of differences between groups
- Equivalence of percentage change

3. Discussion of the Results

The current study determined whether there are statistical differences in any physiological variables between pre-and post-measurement for three research groups: one that was not involved in any athletic activities and two commercial divers for 9-10 years and 5-6 years.

Table 1 shows the arithmetic mean, standard deviation, and the skew coefficient for age, height, and weight for all members of the basic study, where the skew coefficient ranged between (-2.703-0.235), meaning that the skew coefficient is between ±3, which indicates the homogeneity of the research sample as a whole in the age variables. and height and weight.

Table 2 shows the significance of the statistical differences of the ANOVA test in the variables of age, height, weight, occupational age, total number of dives and number of diving hours among the three groups (the first group is non-divers, the second group is commercial diving practitioners from 5-6 years, the third group is diving practitioners The commercial age ranged from 9-10 years, as the P value < 0.05 in the variables of age, height and weight, which indicates that there were no differences and this means that the groups were equal in age, height and weight, while the P value was > 0.05 in the variables of occupational age, total dives and number of diving hours, which indicated There are statistically significant differences between the three groups, which means that the groups are not equitable in these variables before conducting the study, and this is due to the fact that these variables represent the main independent variable for the research, on which the researcher has distributed and classified the study sample since the beginning of the procedural design of the research.

Table 3 demonstrated statistically significant differences between pre-and post-measurement in favor of post-measurement due to increased pulse rate, systolic and diastolic pressures of non-practicing diving (9.1) by 19.75% in pulse rate, 5% in systolic pressure, and 7.91% in diastolic pressure following a physical performance in 25 meters depth in water for 22 minutes in the pressure room. **Table 4** showed substantial variations between pre-and post-measurement in favor of post-measurement due to increased pulse rate, systolic and diastolic pressures of the second group of diving practitioners for 5-6 years by 16.25% in pulse rate, 2.81% in systolic pressure, and 5.19% in diastolic pressure. As shown in **Table 5**, meaningful discrepancies were illustrated between pre-and post-measurement in favor of post-measurement due to elevated pulse rate, systolic and diastolic pressures in the third group of diving practitioners for 9-10 years, as measured by 15.64%, 2.58%, and 4.45% in pulse rate, systolic and diastolic pressures, respectively. For all physiological variables, the percent change rate differences between pre-and post-measurement were in favor of the first group **(**see **Table 6).**

Table 1. N= (18) Mean, SD, Skewness of the research samples pre-experiment

Variables	**Unit**	**Sample (3 groups)**				
		minimum	**Max**	**Mean**	**SD**	**Skewness**
age	Y	31	35	32.56	3.68	-2.703
Height	Cm	176	181	178.87	1.67	-0.124
Weight	KG	84	88	85.78	1.64	0.235

Mean, SD, Skewness of the samples

Skewness (0.235- -2.7) Meaning homogeneity of the samples

Table 2. Statistical difference between the three groups of variables before the experiment

	Data					
variables	**Unit**	**Difference**	**Degree of Freedom**	**Mean of Squares**	**F. Value**	**P. Value**
age	Y	Between groups	2	8.11	0.53	0.614
		In the groups	6	15.33		
Height	Cm	Between groups	2	0.11	0.03	0.97
		In the groups,	6	3.67		
Weight	Kg	Between groups	2	0.11	0.03	0.969
		In the groups,	6	3.56		
Practice age	y	Between groups	2	71.22	1732.41	.000*
		In the groups	6	0.04		
Number & Diving	Numbers	Between groups	2	1350640.78	950.56	.000**
		In the groups	6	1420.89		
Number & Diving hours	Hours	Between groups	2	6146358.23	457.9	.000**
		In the groups	6	13422.98		

P= statistical value (0.05) = $p \geq 0.05$

Table 3. Statistical difference pre-post measurement & Physiological variables & the first group & none practicing divers (n= 12)

Variables	**Unit**	**1st group**				**F. Value**	**P. Value**
		Pre		**Post**			
		Mean	**SD**	**Mean**	**SD**		
Pulse	n/m	82.67	2.08	99	1	-9.80	.010**
Syst. press.	m/H5	120.31	0.58	126.33	1.53	-5.20	.035**
Diast. press	m/H9	80	0	86.32	1.15	-9.50	.011**
Cortisol	Ug/di	5.37	0.81	14.53	2.63	-4.63	.044**
$CD34^+$	%	30.34	1.53	59.66	2.52	-15.81	.004**

P= statistical value (0.05) = $p \geq 0.05$

Table 4. Statistical difference pre-post physiological value & the second group & diving (5-6y.) (n= 12)

Variables	Unit	2nd group				F. Value	P. Value
		Pre		Post			
		Mean	SD	Mean	SD		
Pulse	n/m	78	2	90.68	3.21	-8.6	.013**
Syst. press.	MM/HG	117	1	12.29	0.58	-10	.010**
Diast. press	MM/HG	77.34	0.58	81.31	2.31	-4	.47**
Cortisol	Ug/dI	5.7	0.3	8.8	1.08	-4.47	.046**
$CD34^+$	%	40.66	2.08	65.68	2.08	-10.83	.008**

P= statistical value (0.05) = p ≥ 0.05

Table 5. Statistical difference & pre-post physiological variables & the 3rd group practicing dive (9-10y) (n= 12)

Variables	Unit	3rd group				F. Value	P. Value
		Pre		Post			
		Mean	SD	Mean	SD		
Pulse	n/m	74.66	0.58	86.34	1.53	-17.5	.003**
Syst. press.	MM/HG	114.68	0.58	117.65	0.58	-5.2	.035**
Diast.press	MM/HG	74.67	1.53	78	2	-10	.010**
Cortisol	Ug/dI	5.37	0.42	7.8	0.78	-10.43	.009**
$CD34^+$	%	51.31	2.08	70.67	2.52	-8.84	.013**

P= statistical value (0.05) = p ≥ 0.05

Table 6. Change rate percent & pre-post physiological variables & the three groups

Variables	Change rate percent		
	1st group	2nd group	3rd group
Pulse	19.75	16.25	15.64
Syst. press.	5	2.81	2.58
Diast. press	7.91	5.09	4.45
Cortisol	170.57	54.38	45.25
$CD34^+$	96.63	61.53	37.73

P= statistical value (0.05) = p ≥ 0.05

The increased pulse rate and blood pressure of the three research groups following the post-measurement may be due to the circulatory system responding reflexively to the effect of the physical performance under the pressure of diving. It may increase potential CO2 pressure and respiration effort, which affects the sympathetic nervous system and stress hormones, such as catecholamine. Also, due to cardiac output leading to increased sing pulse rate and blood pressure. These results agree with Bennett PB, Elliott DH [11], and Bennett PB, Elliott DH [25], and Bosco G, Yang et al. [10] previous studies, reporting that various stresses caused pulse rate and blood pressure, which was mediated by the sympathetic nervous system and hormones, resulting in pulse rate and blood pressure [26-28].

Concerning the cortisol hormone, **Table 3** showed a 170.57% increase in cortisol concentration following diving in the case of non-diving practitioners (group 1) and a 54,38% increase in cortisol concentration following diving to a depth of 25 meters for 22 minutes in the case of a group 2. As indicated in **Table 4**, the cortisol concentration increased 54, 38% following diving in the third group of commercial divers for 9-10 years. The reason for the three groups' increased cortisol levels after diving is that the 4-bar pressure underwater stimulates the pituitary gland's ACTH production, stimulating cortisol release from the adrenal gland. It has also been stated that the cortisol concentration increased due to the increased partial pressure of gases, which included stresses influencing the various physiological systems during the diving process [29], [30].

Previous studies demonstrated the critical role of cortisol hormone in converting liver glycogen to glucose and increasing glucose in the liver through the gluconeogenesis of amino acids [31].

Moreover, divers are exposed to stress, which affects the nervous system and stimulates cortisol secretion; additionally, CO_2 levels rise, and partial pressures of oxygen and nitrogen increase hormonal release, especially cortisol and catecholamines, which creates a balance of the body's various systems to function under height pressure [32], [33].

The impact of air scuba dives to a depth of 40 meters on male divers' serum cortisol levels has been investigated, concluding that dicing pressure increased hormonal stress release and cortisol levels increase as diving depth increases [34].

Further, hyperbaric stress in divers and non-divers has been investigated, focusing on neuroendocrine and psychomotor responses, reporting that the hypothalamus almost entirely mediates rises in ACTH secretion in response to emergencies through the release of CRH [35].

This polypeptide is synthesized in the paraventricular nuclei by neurons. The polypeptide is secreted in the median eminence and transported to the anterior pituitary through the hypophysial portal vessels, where it activates ACTH secretion and secretes cortisol, having a wide range of effects on carbohydrate and protein metabolism, including increased protein catabolism, and increased hepatic glycogen and gluconeogenesis.

In the case of $CD34^+$ stem cells, **Table 3** revealed statistically significant differences between pre-and post-measurements in favor of post-measurement, owing to the increased $CD34^+$ in the post-measurement of non-practicing divers by 100.6%, following physical exertion in 25 meters depth for 22 minutes in the pressure room. **Table 4** demonstrated a statistical difference of 61.33% between pre-and post-measurement in favor of post-measurement due to increased $CD34^+$ post-measurement in the second group of commercial divers for 5- 6-years. It can be seen from the data in **Table 5** those significant discrepancies between pre-and post-measurements were revealed in favor of post-measurement, leading to a 37.73% rise in $CD34^+$ post-measurement in the third group of commercial divers for 9-10 years.

It has been reported that increased stress can result in an increase in CD34+ from the bone marrow [36], [37].

Furthermore, a previous study revealed that increased pressure on divers combined with high gas concentrations in the respiratory system could increase $CD34^+$, which acts as a source of red blood corpuscles that aid in the transportation of blood gases such as oxygen and carbon dioxide and increase energy production [38].

A study on the impact of sport diving on stem cells $CD34^+$ and the complete blood picture, sport diving increased $CD34^+$, WBCs, RBCs, and hemoglobin concentrations, all of which contribute to increased energy output and immune boosting (93).

Numerous researchers have indicated that physical effort enhances free radicals, which may significantly contribute to certain body systems such as muscle fibers and vascular degeneration, resulting in increased $CD34^+$ release, which aids in muscle fiber repair and blood cell and capillary regeneration [39], [40].

There is another factor that supports the growth of stem cells by inducing the repair of various cell hazards, such as vascular endothelial growth factor (VEGF) and immune structure SPF, which promote $CD34^+$ release [41].

Concerning the mechanism of stem cell release, it was reported that during the stress of diving or exercise-induced stress, both the nervous and immune systems stimulate bone marrow and bone, increasing the number of osteoclasts, which in turn stimulates stem cell release, catecholamine, and its receptors in the bone, as well as immune cells and their receptors [10].

Previous studies discussed the role of physical activity in stem cell development and the role of stem cell factor SCF in stimulating stem cells, as stem cell factor is needed for the proliferation and self-renewal of hematopoietic stem cells (HSCs) [42-44].

Consequently, the researchers noted that additional factors help define particular lineages. The proliferation and maturation of the cells that enter the blood from the bone marrow are regulated by glycoprotein growth factors or hormones that stimulate the proliferation and maturation of cells in one or more of the committed cell lines. Granulocyte-macrophage colony-stimulating factors are among the factors that promote the development of dedicated stem cells.

Correspondingly, interleukin 1,6,3 works sequentially to transform uncommitted pluripotent stem cells to dedicated progenitor cells. The results from **Tables 7-10** indicated that there was no statistical significance between pre-and post-measurement for the three research groups in all variables of dynamic breathing functions, despite the presence of a decrease in post-measurement, without significance in all variables tested FVC, forced vital ability, FEV1, forced expiratory volume in 1S. Additionally, the results indicated that there were differences in rest in the variables of the three dynamic breathing functions between the three groups, favoring the first group, which does not practice commercial diving, the second group, which practices 5-6 years of diving, and the third group, which practices 9-10 years of diving, implying that those who practice diving are superior to commercial diving practitioners. The present study found that dynamic breathing functions (e.g., FVC, FEV1%, and FEF) decreased slightly following diving in all three groups, especially those with a longer diving period of 9-10 years. These findings may indicate a progressive pathology of the small bronchi over time, matching previous studies [45].

Table 7. Pre and post-dynamic breathing Functions (G1) not about diving

Variables	Measurement units	Group 1				T Value	P-value
		Pre measurement		Post measurement			
		Mean	SD	Mean	SD		
FVC	L/S	4.75	0.13	4.69	0.12	3.46	0.421
FEV1	L/S	4.57	0.45	4.38	0.39	-0.76	0.528
FEV1	%	94.33	1.53	92.33	1.15	2.01	0.327
FEF	L/S	10.17	0.17	10.12	0.17	2.29	0.15

P= statistical value (0.05) = $p \geq 0.05$

Table 8. Pre- and post-dynamic breathing Functions (G2) 5-to-6-year diving

Variables	Measurement units	Group 2				T Value	P-value
		Pre measurement		Post measurement			
		Mean	SD	Mean	SD		
FVC	L/S	4.25	0.06	4.33	0.05	1.45	0.074
FEV1	L/S	4.01	0.08	3.97	0.02	1.3	0.323
FEV1	%	84.67	1.15	83.47	0.58	2	0.184
FEF	L/S	9.55	0.1	9.53	0.11	2	0.184

P= statistical value (0.05) = $p \geq 0.05$

Table 9. Pre- and post-dynamic breathing Functions (G3) 9-to-10-year diving

Variables	Measurement units	Group 3				T Value	P-value
		Pre measurement		Post measurement			
		Mean	SD	Mean	SD		
FVC	L/S	4.16	0.02	4.14	0.02	3	0.235
FEV1	L/S	3.71	0.06	3.69	0.06	4	0.057
FEV1	%	81.33	1.53	80.67	1.15	2	0.184
FEF	L/S	8.86	0.35	8.85	0.35	4	0.057

P= statistical value (0.05) = $p \geq 0.05$

Table 10. ANOVA post measure of dynamic breathing functions (G1, G2, G3)

Variables	Measurement units	Difference	Freedom	Mean of Square	F Value	P-value
FVC	L/S	Between	2	0.28	49.57	0.000**
		Intra	6	0.01		
FEV1	L/S	Between	2	0.61	11.56	0.009**
		Intra	6	0.05		
FEV1	%	Between	2	124	124	0.000**
		Intra	6	1		
FEF	L/S	Between	2	1.21	23.03	0.002**
		Intra	6	0.05		

P= statistical value (0.05) = $p \geq 0.05$

Numerous factors, such as pressure and breathing gas, have been proposed as potential causes of decreased dynamic breathing functions [44]. Other factors unrelated to pressure and breathing gas were identified that might have a detrimental effect on the lungs, such as an improvement in diffusing capacity resulting in vascular engorgement. Via neurogenic mechanisms, Coldwater immersion can cause significant respiratory changes such as hyperventilation and hypocapnia [43]. The short-term effects of diving on lung function have been studied extensively, with several research reporting improvements in SPIROMETRIC indices following wet Cuba dives using air as the breathing gas, but no major changes in lung function following wet dives to 4.5 meters in a pool or 50 meters in a wet hyperbaric chamber. Other studies have indicated a decrease in breathing flows and volume at 27 °C following open sea dives to a depth between 10 and 50 meters or dives in cold water [46].

It has been demonstrated that improvements in lung function after single deep saturation dives could result from processes affecting static and dynamic lung volumes and gas exchange [47].

In terms of the long-term effects of diving on lung function, scientific studies have shown that diving has various impacts on lung function. A controlled study of a large group of Egyptian special forces divers who used scuba with pure oxygen twice weekly for 90 minutes over two years found no variations in ventilatory flows as volumes [48].

However, other research suggested that diving exposure accelerated the loss of FVC over time [15]. In contrast, more recent research on military or recreational scuba divers using air or nitrox found no evidence of lung function loss over time [49], [50]. A study of Singapore Navy divers revealed Ventilatory volumes improved substantially [48].

A previous study reported on the biological changes in CD34+ stem cells following diving in trained divers and the effects of diving on vascular repair mechanisms and cardiovascular changes during underwater static and dynamic breath-hold divers [46], [51].

The researchers concluded that diving affects EPC numbers and circulating angiogenic cells (CAC) function. Since diving causes oxidative stress, which may affect EPC recruitment or survival, functional improvement of CAC may act as a compensatory mechanism to preserve endothelial homeostasis, thus influencing cardiovascular changes while diving.

4. Conclusions

Based on what the study results showed and within the limits of the study sample, its nature, and statistical treatment, the researchers can draw the following conclusions:

1. The results showed the presence of statistically significant differences between the pre-and post-measurement for the benefit of the three research groups through an increase in the rate of pulse and the systolic and diastolic blood pressure and the cortisol hormone in the blood and the percentage of stem cells CD34 +, after performing the physical effort at a depth of 25 meters for 30 minutes in the pressure room (Dry diving).
2. The results showed that there were differences between the three groups in the pre-measurement (rest time) for physiological and biochemical measurements in pulse, systolic and diastolic blood pressure, and stem cell ratio $CD34^+$ for the benefit of the second and third group, and this meant the superiority of commercial diving practitioners from 5-6 years, and 9-10 Years for non-practitioners, and there are statistically significant differences between the second and third group in favor of the third group, which means that commercial diving practitioners from 9-10 years are better in these variables than commercial diving practitioners from 5-6 years.
3. The results showed that there were differences between the three groups in the tribal measurement (rest time) in the variables of the three dynamic breathing functions in favor of the first group who are not practicing diving compared to the second and third group, and this means that others who practice diving are better in these variables than commercial diving practitioners, and there are also differences. Statistically significant between the second and third groups in favor of the second group, which means that commercial diving practitioners from 5-6 years are better in these variables than commercial diving practitioners from 9-10 years.
4. The results showed that there were no statistically significant differences between the three groups in the tribal measurement (rest time). in the cortisol hormone variable in the blood.
5. The results showed that there were differences between the three groups in the post-measurement in physiological and biochemical measurements in the pulse, systolic and diastolic blood pressure variables and the percentage of stem cells CD34 + and cortisol in favor of the second and third group, and this means the superiority of commercial diving practitioners from 5-6 years, and from 9-10 years on. Those who are not practicing in these variables, as well as there, were statistically significant differences in the variable percentage of stem cells CD34 + between the second and third group in favor of the third group, which means that commercial diving practitioners from 9-10 years are better in this variable than commercial diving practitioners from 5-6 years. Likewise, there were no statistically significant differences between the second and third groups in the pulse, diastolic, and cortisol heart variables, although they were better in favor of the third group, but without significant significance.
6. The results showed that there were differences between the three groups in the dimensional measurement in the three dynamic respiratory function variables in favor of the first group not practicing diving for the second and third group, which means that those who practice diving are

better in these variables than commercial diving practitioners from 5-6 years, and 9 -10 years, and there are statistically significant differences between the second and third groups in favor of the second group, which means that commercial diving practitioners from 5-6 years are better in these variables than commercial diving practitioners from 9-10 years.

7. The results showed the positive role of physical exertion and the pressures related to diving in stimulating it and increasing the rate of stem cell production immediately after diving
8. The results showed the positive role in the practice of commercial diving for long periods in increasing the number and percentage of stem cells CD34 +, and that the longer the period of practice increases, the more it contributes to its uniforms.
9. Practicing prolonged commercial diving has positive effects on improving pulse rate and blood pressure.
10. The results showed that with the increase in periods of practice in diving underwater and at different depths and pressures, the physiological response to the hormone cortisol does not disappear completely, but it is more disciplined, due to the adaptation of the nervous system and hormonal system to a high-pressure environment.
11. The results showed that the practice of diving for long periods leads to a decrease in dynamic lung function, but it did not reach the satisfactory rates that prevent diving from practicing.

5. Recommendations

In light of what the results of this study showed and within the limits of the research sample, the researchers recommend the following:

1. The necessity of conducting analyzes to measure the rate of stem cell production by the concentration of CD34 + protein in the blood to identify the nature and condition of divers to develop training programs that improve their functional and practical competence.
2. The necessity to conduct periodic follow-up measurements of the dynamic breathing functions of commercial divers.
3. The necessity of developing codified training programs to develop and raise the job efficiency of the lungs' functions for commercial divers.
4. The necessity to conduct periodic follow-up measurements of the dynamic breathing functions of commercial divers.
5. The necessity of establishing codified training programs to develop and raise the physical efficiency of commercial divers.
6. The necessity of developing codified training programs to develop and raise the job efficiency of the lungs' functions for commercial divers.
7. Carrying out more scientific research to know the effect of regularity in years in the practice of commercial diving on physiological changes on various body systems.
8. Carrying out more scientific research to know the physiological adaptations that happen to the diver and comparing them with other sports players.
9. The necessity of conducting annual periodic tests (medical, physiological, and physical) for everyone who practices diving in general and commercial diving in particular to know the impact of diving on different body systems over the years of practice.
10. Carrying out more similar studies to know the role of stem cells in improving the level of performance of players in all sports, whether team or individual.
11. Conducting studies to compare divers using breathing mixtures (Hilux, Tri-Mix, nitrox, and normal air) and their effect on stem cell and cortisol activity.
12. Conduct studies to identify hormones and genes that regulate the work of stem cells.
13. Conducting more studies to determine the role of stem cells in the selection process, whether in diving or other sports.
14. The provision of modern laboratory tools and equipment for the competent authorities to perform stem cell analysis processes for.
15. Relying on $CD34^+$ stem cell levels is one of the important physiological indicators to determine the functional proficiency of divers.

Contributions

The authors of this original article. Collected, organized, and analyzed all the data utilized in this article and concluded from the results of the data analysis.

Conflict of Interest

The authors declare no conflicts of interest.

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