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Ocena czynników wpływających na skuteczność terapii integracji sensorycznej u dzieci w wieku przedszkolnym i wczesnoszkolnym

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Benefit of breath-holding training on the concept of recreational freediving in healthy adults – a systematic literature review

Korzyści płynące z treningu wstrzymywania oddechu w kontekście rekreacyjnego nurkowania na wstrzymanym oddechu u zdrowych dorosłych – systematyczny przegląd literatury

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Abstract

Background. Breathing is a crucial process that commences at the moment of birth and ceases with one's passing. Through breathing, essential oxygen is supplied to all the body's parts, organs, and cells, sustaining life. Some numerous breathing techniques to optimize the advantages of breath-holding exercises. Freediving training is believed to be able to increase respiratory efficiency. The exercise is done by controlling of breathing and a stable heart rate so human can hold breath for a while, dive deeper and dive safely. These techniques are also employed in the preparation and meditation of postures, enhancing the focus and clarity of the mind to maximize the benefits of the practice.

Methods. All studies were screened on an individual basis, considering a set of specific criteria and key data such as affiliation of authors, type of study, year of publication, type of breath-hold exercise benefit in healthy. The study was designed in accordance with the standards of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyzes).

Results. Based on the systematic review process, selected and extracted data for each article obtained, a detailed description of the researcher's name, title, research design, respondents, strengths and research results, and research limitations are summarized.

The inclusion criteria: International Journal and Research Design include Controlled Intervention Studies, Observational Cohort and Cross-Sectional Studies, Case-Control Studies, Case Series Studies, and Articles containing elements of breath hold benefit training. Quality assessment tools of the paper use NHLBI with low, and medium, assessment criteria. In this systematic review process, 230 Article collections were using Scopus, Pubmed and GS Databases with the keywords namely breath hold "AND" training "AND" benefit.. The stage continued by searching for the duplicate articles and obtained 34 out of 230 databases so that 196 articles were obtained before the screening stage. The first screening stage continued by excluding the title and abstract and obtained 160 articles from the 196 databases, so 36 articles were obtained at the screening stage. The next stage was eligibility, excluding 11 articles based on IMRAD (Introduction, Method, Result, and Discussion)is not clear, excluding 5 article Systematic Review, and excluding 6 article study reports were not included where finally meet 14 articles were evaluated for eligibility based on the title and abstract as well as the entire article excluded on inclusion and exclusion were obtained that matched the article criteria to be reviewed in this study

Conclusion.This comprehensive review highlights a number of studies exploring the relationship between breath-holding exercises and associated health benefits. These studies cover a wide range of aspects, including the impact of physical activity on freedive training, the benefits of diaphragmatic breathing on lung function, and the effectiveness of mental imagery (MI) training in improving breath-hold performance. Additionally, studies have shown significant improvements in cardiorespiratory function in individuals with bronchial asthma, chronic obstructive pulmonary disease, and cancer. These improvements were evidenced by positive changes in pulse rate, blood pressure, respiratory function measurements, and overall quality of life.

Keywords

breath-holding training,, freediving, benefit

Streszczenie

Wprowadzenie. Oddychanie jest kluczowym procesem, który rozpoczyna się w momencie narodzin i kończy wraz ze śmiercią. Dzięki oddychaniu, niezbędny tlen dostarczany jest do wszystkich części ciała, organów i komórek, podtrzymując życie. Istnieje wiele technik oddychania, mających na celu optymalizację korzyści płynących z ćwiczeń na wstrzymanym oddechu. Uważa się, że trening freedivingu może zwiększyć efektywność oddechową. Ćwiczenie to polega na kontroli oddychania i stabilizacji tętna, co umożliwia człowiekowi wstrzymywanie oddechu na pewien czas, nurkowanie głębiej i bezpieczne zanurzanie. Techniki te są również stosowane w przygotowaniu i medytacji pozycji, zwiększając skupienie i jasność umysłu, aby maksymalizować korzyści z praktyki.

Metody. Wszystkie badania były przesiewane indywidualnie, biorąc pod uwagę zestaw określonych kryteriów i kluczowych danych, takich jak przynależność autorów, rodzaj badania, rok publikacji, typ korzyści z ćwiczeń na wstrzymanym oddechu u zdrowych. Badanie zostało zaprojektowane zgodnie ze standardami PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

Wyniki. W oparciu o proces systematycznego przeglądu, wyselekcjonowane i wyekstrahowane dane dla każdego artykułu zostały uzyskane, szczegółowy opis nazwiska badacza, tytułu, projektu badawczego, respondentów, mocnych stron i wyników badania oraz ograniczeń badania są podsumowane. Kryteria włączenia: Międzynarodowe Czasopismo i Projekt Badawczy obejmują Kontrolowane Badania Interwencyjne, Obserwacyjne Badania Kohortowe i Przekrojowe, Badania Kontrolne Przypadków, Badania Serii Przypadków oraz Artykuły zawierające elementy treningu korzyści z wstrzymywania oddechu. Narzędzia oceny jakości pracy używają NHLBI z niskimi i średnimi kryteriami oceny. W tym procesie przeglądu systematycznego, 230 kolekcji artykułów zostało użytych z baz danych Scopus, Pubmed i GS z słowami kluczowymi: wstrzymywanie oddechu "AND" trening "AND" korzyść. Etap kontynuowany był przez wyszukiwanie duplikatów artykułów, uzyskując 34 z 230 baz danych, tak że przed etapem przesiewania uzyskano 196 artykułów. Pierwszy etap przesiewania kontynuowano przez wykluczenie tytułu i abstraktu, uzyskując 160 artykułów z 196 baz danych, więc na etapie przesiewania uzyskano 36 artykułów. Kolejny etap to kwalifikowalność, wykluczając 11 artykułów na podstawie niejasności IMRAD (Wprowadzenie, Metoda, Wynik i Dyskusja), wykluczając 5 artykułów przeglądów systematycznych, i wykluczając 6 raportów badawczych, gdzie ostatecznie ocenie podlegało 14 artykułów na podstawie tytułu i abstraktu, jak również całego artykułu wykluczonego na podstawie kryteriów włączenia i wykluczenia, które pasowały do kryteriów artykułu do przeglądu w tym badaniu.

Wnioski. Niniejszy kompleksowy przegląd podkreśla szereg badań eksplorujących związek między ćwiczeniami na wstrzymanym oddechu a związanymi z nimi korzyściami zdrowotnymi. Badania te obejmują szeroki zakres aspektów, w tym wpływ aktywności fizycznej na trening freedivingu, korzyści płynące z oddychania przeponowego na funkcję płuc oraz skuteczność treningu wyobrażeń mentalnych (MI) w poprawie wydajności wstrzymywania oddechu. Ponadto, badania wykazały znaczącą poprawę funkcji kardiorespiracyjnej u osób z astmą oskrzelową, przewlekłą obturacyjną chorobą płuc i rakiem. Te poprawy zostały potwierdzone przez pozytywne zmiany w tętnie, ciśnieniu krwi, pomiarach funkcji oddechowej oraz ogólnej jakości życia.

Słowa kluczowe

trening wstrzymywania oddechu, freediving, korzyści

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Introduction

Humans naturally possess diving abilities in terms of breath-holding duration and reachable depths while submerged. Despite the existence of this capability, there isn't a real necessity for most humans to venture into the water. The ability to hold one's breath, a key aspect of free diving, is primarily practiced in hunting endeavors. However, in today's world, free diving is pursued by various groups of people. They engage in free diving for recreational purposes, considering it a natural extension of activities like swimming, taking showers, and find it to be an accessible form of diving [1]. Freediving is a swimming sport where individuals dive to the water's bottom without a breathing apparatus, holding their breath [2].

Schagatay (2011) points out [3], The characteristic of freediving, unlike most sports, is the absence of regular breathing. Therefore, although freediving is quite popular, if done without proper supervision, education and training, it can be dangerous.

Xavier (2006), stated breathing is a crucial process that commences at the moment of birth and ceases with one's passing. Through breathing, essential oxygen is supplied to all the body's parts, organs, and cells, sustaining life. The rhythm of anxious energy can be regulated through pranayama, leading to a healthy body and mind. Ancient yogis developed numerous breathing techniques to optimize the advantages of breath-holding exercises. These techniques are also employed in the preparation and meditation of postures, enhancing the focus and clarity of the mind to maximize the benefits of the practice[4]. On the other hand, free diving training is believed to be able to increase respiratory efficiency. The exercise is done by controlling your breathing and a stable heart rate so you can hold your breath for a while, dive deeper and dive safely [5].

The aim of this systematic review was to examine the current state of scientific knowledge on the benefit of breath-holding training on the concept of recreational freediving in healthy adults.

Methods

Preparation of the research design, all studies were screened on an individual basis, considering a set of specific criteria and key data such as affiliation of authors, type of study, year of publication, type of breath-hold exercise benefit in healthy. The study was designed in accordance with the standards of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyzes) [6].

Study search methodology

Data collection was identified by 21 October 2023. To obtain the studies, the literature search was conducted in October 2023 using database sources such as Scopus, PubMed, and Google Scholar. The literature search was carried out using keywords that became the main topic terms, namely breath hold "AND" training “AND” benefit. Researchers set no limits in searching for related literature, including journals, to obtain valid and current information. Figure 1 describes the process of selecting articles according to the guidelines of the Preferred Reporting Literature Review and Meta-analysis (PRISMA).This review report use inclusion and exclusion criteria (Table 1).

Table 1. Inclusion criteria and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Scientific Article	1. Books, Book chapters
2. International Journal	2. IMRAD is not clear
3. Controlled Intervention Studies, Observational Cohort and Cross-Sectional Studies, Case-Control Studies, Case Series Studies	3. Systematic Review
4. Articles containing elements of breath hold "AND" training “AND” benefit	4. Study reports not included

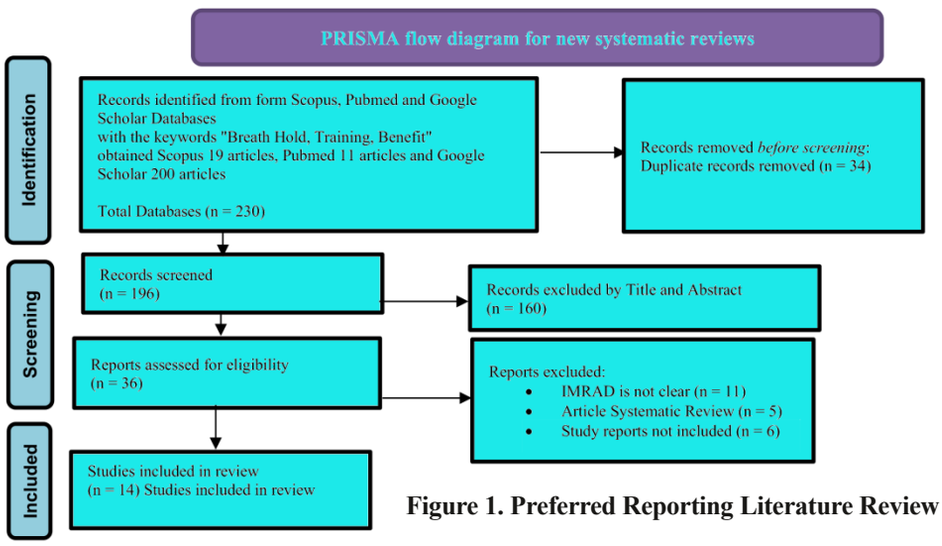

Figure 1. Preferred Reporting Literature Review and Meta-analysis (PRISMA)

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Screening results by considering a series of specific criteria and important data such as author affiliation, type of study, year of publication, type of benefits of breath holding exercises in health. In accordance with PRISMA (Preferred Reporting Items for Systematic Review and Meta Analysis) standards, the following statistical data were obtained.

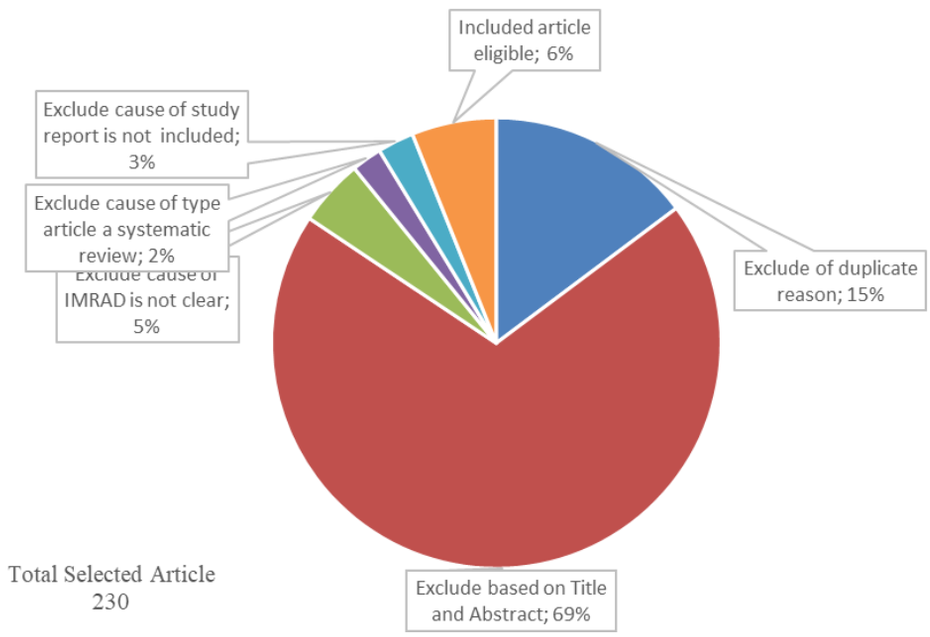

Figure 2. Preferred Reporting Literature Review and Meta-analysis (PRISMA)

Table 1. Characteristics of articles

Authors	Research methods	Sample characteristics	Studied parameter	Conclusion
Costalat G, et.al (2014)[7]	Cross-sectional Study	Breath-hold divers BHDs (n = 7) and a control group of non-divers (NDs = 7)	Test breath-hold (BHD) divers experience repeated bouts of intermittent hypoxia and hypercapnia during prolonged breath-holds. It has thus been hypothesized that their specific training may develop an increased chemoresponse to hypoxia associated with a decreased ventilatory response to hypercapnia.	These findings indicate that trained breath-hold divers, who often experience repeated bouts of hypoxia/hypercapnia, only exhibit heightened chemo-responsiveness to poikilocapnic hypoxia.
Fernandez F (2019) [8]	Cross-sectional Study	Twenty-nine male breath-hold divers	Study aimed to analyze the effects of physical conditioning inclusion on apnoia performance after a 22-week structured apnoia training program. were allocated into: (1) cross-training in apnoia and physical activity (CT; n = 10); (2) apnoia training only (AT; n = 10); and control group (CG; n = 9). Measures were static apnoia (STA), dynamic with fins (DYN) and dynamic no fins (DNF) performance, body composition, hemoglobin, vital capacity (VC), maximal aerobic capacity.	Cross training (CT) seems to be the most effective method for improving DNF (dynamic apnoia without fins) performance. The post-hoc analysis revealed that CT was the only group where the mean difference was significant both before and after training. Including physical activity in apnoia training led to increased vital capacity (VC) and maximal oxygen uptake (VO2max) in breath-hold divers. Those who engaged in mixed training, combining physical and hypoxic training, achieved enhanced DNF performance.
Simona Mrakic (2019) [9]	Cross-sectional Study	Six divers (mean age 46.6 ± 9.3 years; height 176 ± 4 cm; BMI 25 ± 2.9 kg/m^2).	Research aimed to investigate the effect of breath-hold diving on oxidative stress damage, assessing ROS (reactive oxygen species) production. Nitric oxide metabolites, inducible nitric oxide synthase (iNOS), aminothiols, and renal function were also evaluated as markers of redox status and renal damage.	The research results show that Excessive production of ROS (reactive oxygen species) and the resulting oxidative damage to membrane lipids, along with a decrease in antioxidant capacity, reflect hypoxic conditions that usually occur in the last few meters below the surface during breath-holding dives [9].

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Authors	Research methods	Sample characteristics	Studied parameter	Conclusion
Francisco de Asís-Fernández (2020) [10]	Randomised crossover trial experiment	Fifteen breath-hold divers	Study to determine training intervention High-intensity interval training (HIIT) and inspiratory muscle training (IMT) for 20 minutes, three days per week for four weeks were randomized with a two-week washout period of maximal dynamic exercise apnoia.	Maximum Training produced a reduction in SpO_2 recovery time compared to HIIT after maximal dynamic apnoia.
Laishram et.al (2022) [4]	Pre test -post test experimental research	Thirty male soccer players (age 18 – 25 year) (n = 15) and control group (n = 15) were selected from Manipur University	The Pranayama Breath-hold exercises were carried out for the period of six weeks, five days training (Monday to Friday) and 60 minutes each session to the training group where no special exercise was administered to the control group.	The pranayama Breath-hold training shown significantly improved breath-holding capacity and the control group had insignificant improvement.
Martin J Barwood (2006) [11]	Cross-sectional Study	32 subjects who completed 2 until 2.5-min, head-out immersions in 11°C water.	subjects were matched on initial maximum breath-hold time on immersion (BHwater) and allocated to either a psychological intervention group (PIG) or control group (CG). psychological skills intervention comprising 4 interlinked training sessions covering goal-setting, arousal regulation, mental imagery, and positive self-talk.	Psychological influences may account for a significant amount of the variability in the respiratory responses during Cold Water Immersion, and may be a key factor in determining the chances of survival following accidental immersion.
Amleshkumar P Patel (2021) [12]	Pre test -post test experimental research	30 male and female rifle and pistol shooting. Players from Khanpur Rifle Clube, Ahmedabad from 15 to 30 years of age.	Pranayama breath holding exercises were carried out for experiments on subjects for a period of 8 weeks.	There are significant differences between the average pre-test and post-test in breath holding capacity test with a positive mean difference which means there is is an increase in the subject's breath-holding capacity.
Saoji A et.al (2018) [13]	Randomised crossover trial experiment	One hundred sixteen subjects were randomly assigned to experimental (n = 60) and control (n = 56) groups.	study assessed the correlation between the duration of yoga practice with state mindfulness, mind-wandering, state anxiety and additional 20 min of yoga breathing with intermittent breath holding compared 8 week treatment to regular yoga practice as a control group.	An additional practice of yoga breathing with intermittent breath holding was found to enhance the psychological functions in young adult yoga practitioners.
Thiago Ferreira Dias Kanthack (2019) [14]	Pre test -post test experimental research	Healthy adult participants without history of chronic disease or neurologic disorders were recruited from the Sports Sciences department of the University Claude Bernard Lyon 1 (n = 18, 9 men, age range: 20-25 years old). They had no previous experience of breath-hold but a regular practice of terrestrial sports (soccer, climbing, jogging, and rugby).	The purpose of the present study was to investigate the effect of congruent and incongruent MI (Mental Imagery) practice on maximal breath-hold performance.	The purpose of the present study was to investigate the effect of congruent and incongruent MI practice on maximal breath-hold performance. Data confirmed the hypothesis that MI of breathing, but not MI of breath-holding, elicited increased breath-hold performance. The influence of MI of a breathing state on psychological and physiological factors determining the break-point of breath-holding might account for these beneficial effects.
Kun Yang et al (2022) [15]	Cross-sectional Study	12 local student-athletes with no BH exercise experience who performed BH jogging and BH jumping rope dynamic apnoia protocols, five times weekly for 8 weeks. The same training task was performed by the control group (n = 10) without Breath Hold.	This study aimed to evaluate the effects of apnoia training on spleen size and hematological parameters.	Eight weeks of dry dynamic apnoia training increased spleen size and decreased the number of circulating bulky platelets in the athletes who were assessed in this study. However, the baseline HGB(haemoglobin) levels of the athletes were not altered by the training program.
Vaibhav Rai et.al (2014)[16]	Experimental Research	The subjects was in range 12 to 15 years. Control group (n = 15) and experimental group (n = 15).	The purpose of this research was to determine the effect of 8 weeks yoga practices (Pranayama) on Breath holding capacity of school going children of Mahilpur.	It showed that eight weeks yoga practices (Pranayama) significantly increased the breath holding time of school children.

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Authors	Research methods	Sample characteristics	Studied parameter	Conclusion
C Durai et.al (2014) [17]	Experimental Research	20 participant with age ranged from 18 to 25 years. The selected participants were randomly divided into two groups such as group 'A' 'Bhastrika pranayama practices' (n = 10) and group 'B' acted as control group (n = 10)	Group experiment Group A' undergoing Bhastrika pranayama yoga practice for three days and each session lasts one hour for six weeks. However, the control group, Group B, was not specifically explained training but they participate in their regular schedule. the ability to hold your breath time is measured before and immediately after the training program.	1. There was significant improvement on breath holding time due to the effect of Bhastrika pranayama practices among M.S. University hostel men students. 2. However the control group had not shown any significant improvement on any of the selected variables
Praveen Bhardwaj (2021) [18]	Experimental Research	40 Participant (20 males and 20 females) students aged between 18-20 year	This research was conducted on subjects who were physically and mentally healthy, non-smokers, free from respiratory or heart disease or other systemic diseases, cooperative and able to understand the procedure and not take other actions. Any form of physical exercise or yoga during the study period was included in this study before and after one month of practicing diaphragmatic breathing	There was a significant increase in peak expiratory flow rate (PEFR) and breath holding time (BHT) after 1 month of diaphragmatic breathing maneuvers which illustrates the benefits of diaphragmatic breathing on lung function.
Vigneshwaran G (2015) [19]	Experimental Research	20 male hokkey players randomly selected as subjects from the M.D.T Hindu college, Tirnelveli, and Tamilnadu, India. Their age ranged from 18 to 22. The selected participants were randomly divided into two groups such as Group A 'pranayama practices training (n = 10) and Group 'B' acted as control group (n = 10).	The purpose of the study was find out the influence of pranayama practice on breath holding among hockey players.	The pre and post-test was concluded that the pranayama practices training group had shown significantly improved in breath holding time. However the control group had not shown any significant improvement on any of the selected variable such as breath holding.

Discussion

The literature review clearly shows many studies have attempted to demonstrate a relationship between breath-holding exercise parameters and health benefits. One such study, authored by Fernandez F (2019) [8], showed significant results both before and after training. Including physical activity in freedive training led to increased vital capacity (VC) and maximal oxygen uptake (VO_2max) in breath-hold divers. Another study, authored by Praveen Bhardwaj (2021) [18], showed that there was a significant increase in peak expiratory flow rate (PEFR) and breath holding time (BHT) after 1 month of diaphragmatic breathing maneuvers, illustrating the benefits of diaphragmatic breathing on lung function. Other research by Praveen Bhardwaj (2021) [18] shows that adding congruent and incongruent MI (mental imagery) training provided maximum breath-holding performance compared to those not given mental imagery treatment. Similarly, Martin J Barwood (2006) [11] reported that psychological interventions, comprising 4 interlinked training sessions covering goal-setting, arousal regulation, mental imagery, and positive self-talk, may account for a significant amount of the variability in respiratory responses during Cold Water Immersion and may be a key factor in determining survival chances following accidental immersion. In line with other research Kun Yang et al (2022) [15], report that eight weeks of dry dynamic apnoia training increased spleen size and decreased the number of circulating large platelets in athletes assessed in the study.

In activities related to yoga, such as pranayama breath-hold training, there was a significant improvement in breath-holding capacity, whereas the control group showed insignificant improvement [4, 12, 13, 16, 17, 19. Research studies have shown a noteworthy impact on cardiorespiratory functions in patients with bronchial asthma. This improvement is evidenced by changes in pulse rate, systolic blood pressure, and respiratory function measurements. Additionally, there was a reduction in the frequency and severity of attacks, as well as a decrease in medication requirements, leading to an overall enhancement in the quality of life (QOL). Similarly, patients with chronic obstructive pulmonary disease experienced improvements in symptomatology, activity levels, and overall impact scores. Cancer patients also reported an enhancement in their QOL [20].

Breath holding time and the underwater environment are the two main challenges, which accompany freediving [21]. Freediving, also known as apnoia or breath-hold diving, is one of the oldest and most extreme sports globally, characterized by diving without a respirator. contemporary issues. Immersion in water causes a physiological response, where blood is pushed from peripheral veins to the chest and heart. Autonomic responses during diving include bradycardia, peripheral vasoconstriction, and splenic contractions, all of which aid in efficient oxygen consumption [22]. Maximum Training produced a reduction in SpO_2 recovery time compared to High-intensity interval training (HIIT) after maximal dynamic apnoia. [10]. Breath-hold (BHD) divers experience repeated bouts of

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intermittent hypoxia and hypercapnia during prolonged breath-holds. It has thus been hypothesized that their specific training may develop an increased chemoresponse to hypoxia associated with a decreased ventilatory response to hypercapnia[7]. Excessive ROS (reactive oxygen species) production and the resulting oxidative damage to membrane lipids as well as a decrease in antioxidant capacity also reflect hypoxic conditions. in breath holding dives usually occur in the last few meters below the surface [9].

Freediving exercises, which involve regulating a steady breath and heart rate, are believed to increase respiratory efficiency, enabling divers to hold their breath for longer periods, dive deeper, and do so safely. Freediving is a challenging sport conducted in extreme environments, and if attempted by inexperienced, untrained, or competitive divers, it can result in severe injuries or even fatalities. Nevertheless, the risk of harm can be minimized through responsible practices, adequate training, and the implementation of proper safety measures [5].

Conclusion

This comprehensive review highlights a number of studies exploring the relationship between breath-holding exercises and associated health benefits. These studies cover a wide range of aspects, including the impact of physical activity on apnoia training, the benefits of diaphragmatic breathing on lung function, and the effectiveness of mental imagery (MI) training in improving breath-hold performance. Additionally, studies have shown significant improvements in cardiorespiratory function in individuals with bronchial asthma, chronic obstructive pulmonary disease, and cancer. These improvements were evidenced by positive changes in pulse rate, blood pressure, respiratory function measurements, and overall quality of life.

Freediving, also known as apnoia or breath-hold diving, presents unique challenges regarding breath-hold time and the underwater environment. It is considered one of the most extreme sports globally, and its practitioners benefit from autonomic responses such as bradycardia during diving and peripheral vasoconstriction. Maximal exercise has been shown to reduce SpO2 recovery time compared with high-intensity interval training (HIIT) after maximal dynamic apnoia. Additionally, it is worth noting that breath-holding divers experience repeated bouts of intermittent hypoxia and hypercapnia during prolonged dives, which may lead to specific adaptations in their chemo response to hypoxia and ventilatory response to hypercapnia.

Although freediving offers the opportunity to improve breathing, the sport should be approached with caution, especially for inexperienced or untrained individuals. Proper training, responsible practices and implementation of safety measures are essential to minimize potential risks and ensure a safe diving experience.

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