Dajana Zoretić [1,*]
Tomislav Biloš [1]
Ivan Krakan [1]

ANALYSIS OF APNEA DIVING DEVELOPMENT TRENDS IN POOL DISCIPLINES FROM 2002 TO 2021

ANALIZA TRENDOV RAZVOJA POTAPLJANJA Z APNEJO V BAZENSKIH DISCIPLINAH OD LETA 2002 DO 2021

ABSTRACT

Apnea diving as a sport has evolved to such an extent that many professional divers have managed to achieve results that were considered impossible ten years ago. The predictions of doctors and experts in static apnea, long-distance diving and achievable depths have been exceeded. The aim of this research is to analyze this trend and determine the development curve for the best results in the world between professional apnea divers in pool disciplines over the last 20 years. The sample of subjects in this work consists of the three best world results of free-breath divers in pool disciplines (STA, DNF, DNY) from 2002 to 2021. The variables used in the research are dynamics without flippers (DNF), dynamics with flippers (DYN) and statics (STA) in men. The data was collected from the official websites of the International umbrella diving organizations - AIDA and CMAS. Collected data was processed using a method, algorithm and trend analysis program in the Statistica 13.0 software package. A polynomial regression analysis was used to analyze the development trend of the best results in a given year for each discipline. The coefficient of determination (STA Multi. R=0.77 p≥0.00, DYN Multi. R=0.87 p≥0.00, DNF Multi. R=0.90 p≥0.00) of the positive correlation of the results, while statistical significance was determined by the analysis as a consequence of the constant change in the results. According to the data obtained from the research, a linear increase in results in all three disciplines (statics, dynamics without flippers, dynamics with flippers) between 2002 and 2021 can be determined. According to the analyzed literature, important success factors are knowledge of certain physiological properties, the physical condition of the individual and the optimization of energy.

Keywords: apnea, trend analysis, static apnea, dynamic without fins, dynamic with fins

[1]*University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia*

IZVLEČEK

Potapljanje z apnejo se je kot šport razvilo do te mere, da je mnogim profesionalnim potapljačem uspelo doseči rezultate, ki so pred desetimi leti veljali za nemogoče. Napovedi zdravnikov in strokovnjakov s področja statične apneje, potapljanja na dolge razdalje in dosegljivih globin so bile presežene. Namen te raziskave je analizirati ta trend in določiti razvojno krivuljo za najboljše rezultate na svetu med profesionalnimi potapljači z apnejo v bazenskih disciplinah v zadnjih 20 letih. Vzorec preiskovancev sestavljajo trije najboljši svetovni rezultati potapljačev v bazenskih disciplinah apneje (STA, DNF, DNY) od leta 2002 do 2021. Spremenljivke, uporabljene v raziskavi, so dinamična apneja brez plavuti (DNF), dinamična apneja s plavutmi (DYN) in statična apneja (STA) pri moških. Podatki so bili zbrani na uradnih spletnih straneh mednarodnih krovnih potapljaških organizacij - AIDA in CMAS. Zbrani podatki so bili obdelani s programom za analizo metod, algoritmov in trendov v programskem paketu Statistica 13.0. Za analizo trenda razvoja najboljših rezultatov v posameznem letu za vsako disciplino je bila uporabljena polinomska regresijska analiza, medtem ko je bila statistična značilnost določena z analizo kot posledica konstantne spremembe rezultatov. Koeficient determinacije (STA Multi. R=0.77 p≥0.00, DYN Multi. R=0.87 p≥0.00, DNF Multi. R=0.90 p≥0.00) kaže pozitivne korelacije rezultatov. Glede na podatke, pridobljene z raziskavo, je mogoče ugotoviti linearno naraščanje rezultatov v vseh treh disciplinah (statična apneja, dinamična apneja brez plavuti in s plavutmi) med letoma 2002 in 2021. Glede na analizirano literaturo so pomembni dejavniki uspeha poznavanje določenih fizioloških lastnosti, telesna pripravljenost posameznika in optimizacija energije.

Ključne besede: apneja, analiza trendov, statična apneja, dinamična apneja brez plavuti, dinamična apneja s plavutmi

Corresponding author*: Dajana Zoretić,

University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia
E-mail: dajana.zoretic@kif.unizg.hr

INTRODUCTION

Ever since the first apnea diving competition was organized, there has been a debate about when the ultimate limits of this mystical sport will be reached, and what factors will be key to determining those limits. To date, free-breath divers have largely exceeded all predictions of doctors and experts in static apnea, long-distance diving and reachable depths. A common factor in all competitive disciplines is the duration of apnea, which can be prolonged by any means that increases total gas storage capacity, increases tolerance to asphyxia (suffocation) or slows metabolism (Schagatay, 2009). These main factors can be divided into several physiological and psychophysiological factors. As in other sports, the main goal in competitive apnea diving is to increase results above known limits. While a beginner can improve their results by pushing themselves closer to their personal limits, top apnea divers can increase their apnea time just by pushing their personal limits through training.

To achieve this, it is essential to identify factors predicting results and which of these factors can be improved by training. Great progress has been made in all diving disciplines in recent years, and in static apnea, the ten-minute barrier was broken for the first time, while the average person can hold their breath for only about 30 seconds (LeRoy, 2017). However, current training methods and strategies suggest that apnea duration can be extended even further, while freedivers themselves predict that the ultimate limit will be 15 minutes, which seems physiologically possible, due to the improvement and use of techniques to further slow down the metabolism (Schagatay, 2009). The main goal is to achieve maximum performance in one dive.

Records have been set at almost every competition and there is still no sign of this trend slowing down. The male world record in deep diving (CWT) is -130 m, the record in distance diving with flippers (DYN) is 300 m, and for breath-holding at rest (STA) is 11:35 min. Women's world records -114 m (CWT), 275 m (DYN) and 9:02 min (STA), 201 m (DNF), which are equivalent to men's world records set just a few years ago and are developing just as rapidly. Part of the explanation for this phenomenon is that the number of competitors is increasing and there is an increasing number of relevant scientific research on the world's best apnea divers. In addition, diving techniques and strategies have advanced significantly in recent decades. An undoubtedly important aspect of the development and spread of effective training methods is the emergence of systematic apnea training. The complexity of apnea diving is particularly evident in the need for excellent coordination in numerous dimensions, such as abilities and

traits in the current mental state of the competitor. The success of a apnea diver is determined by the synergy of technique, level of training for hypoxic and hypercapnic conditions, energy capacity and motor skills (Drviš, 2012). Previous research comparing apnea divers with people who do not do sports has shown differences in psychological factors that give astonishing results. The results indicate that apnea divers achieved lower scores in terms of anxiety and stress symptoms, compared to people who do not do sports. The results obtained below indicate that apnea divers are individuals who have fewer symptoms of stress and anxiety (Alkan, Akis, 2013). The main characteristic of apnea, which distinguishes it from other sports, is that in apnea the success and performance of divers under water is related to their psychological and physiological limits (Alkan, Akis, 2013). The average diver should aim for good cardiovascular conditioning and aerobic activity at least three days a week for a minimum of 30 minutes. In addition, good physical preparation can help the diver in general and better prepare them for the challenges of diving (Jablonski, 2000:121). Dujić et al. (2013:303) state that, "success in apnea diving depends on how well the diver tolerates the physiological and psychological stress associated with the depth and duration of the dive".

Man has the ability to adapt to the conditions of diving under water, thanks to the inherited mammal reflexes. It is precisely this kind of modification that enable the human body to adapt to the depths and endure more without breathing than would be possible without this reflex. Although man continuously surpasses former theories about the possibility of holding their breath underwater, practicing maximum apnea can lead to numerous health problems and long-term organ damage, however, the long-term risks of extreme apnea diving have not yet been sufficiently investigated. Exposure to extreme depths and long-term apnea can cause dangerous consequences and acute health problems such as "lung collapse, barotrauma caused by pressure changes during immersion and ascent, pulmonary edema and alveolar hemorrhage, cardiac arrest, fainting, nitrogen narcosis, decompression sickness and even death" (Dujić et al., 2013:302).

Newer research and studies are studying adaptation mechanisms that enable humans to dive to extreme depths of more than 100 meters without any breathing equipment. "These adaptive mechanisms include peripheral vasoconstriction, bradycardia with reduced cardiac output, reactive hypertension, and a blunted response to hypercapnia" (Scherhag et al., 2005). The aim of this research is to analyze this trend and determine the development curve of the best results in the world of professional apnea divers in pool disciplines in the last 20 years.

METHODS

The subject sample for this research consists of the three best world results of free-breath divers in pool disciplines (STA, DNF, DNY) from 2002 to 2021. The variables used in the research are dynamics without flippers (DNF), dynamics with flippers (DYN) and statics (STA) in men. The data was collected from the official websites of the International umbrella diving organizations - AIDA and CMAS. Collected data was processed using the method, algorithm and trend analysis program from the Statistica 14.0 software package. A polynomial regression analysis was used to analyze the development trend of the best results in a given year for each discipline. For the analyzed disciplines, one-dimensional changes in the condition of divers over the years are shown, where over a period of time a change in one quantitative variable was registered.

RESULTS

Table 1 shows the three best apnea diving results in the "statics" discipline in the period from 2002 to 2021, as well as descriptive statistics for the results shown. According to the given data, the most success in the statistics discipline was achieved in 2017 with a result of 10 min and 45 s.

Table 1. List of the three best results, expressed in minutes, in the "statics" discipline, arranged by year and with their descriptive statistics from 2002 – 2021.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.	5:31	6:31	8:58	7:34	8:33	8:40	8:17	9:03	8:42	10:23
2.	5:12	6:04	8:56	7:13	7:27	7:21	8:05	8:09	8:35	8:35
3.	5:03	5:35	8:07	6:56	7:18	7:16	7:57	8:02	8:15	8:18
A.S.	5:15	6:03	8:40	7:14	7:46	7:45	8:06	8:24	8:30	9:05
ST.DEV.	14.30	28.00	28.89	19.04	40.95	47.12	10.07	33.38	14.01	67.80
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
1.	10:05	9:19	10:32	8:21	9:14	10:45	9:42	9:35	9:02	8:52
2.	9:21	8:44	9:04	8:08	9:05	9:58	9:26	9:16	8:51	9:28
3.	8:38	8:06	9:04	8:33	8:57	9:36	9:05	9:12	8:50	8:53
A.S.	9:21	8:43	9:33	8:20	9:05	10:06	9:24	9:21	8:54	9:04
ST.DEV.	43.50	36.51	50.81	12.50	8.51	35.25	18.56	12.29	6.66	20.50

Legend: A.S. - arithmetic mean, ST. DEV. - standard deviation

Figure 1 shows the best results in the period from 2002 to 2021 in the discipline "statics". While analyzing the results, a relative growth is visible in the period from 2005 to 2017, with occasional intervals of decline (2013, 2015), while the best result was achieved in 2017, and in the years after that, a further decline was recorded compared to 2017. The coefficient of determination in Table 2 shows the link of moderate positive correlation of the results, while the analysis established statistical significance as a consequence of the constant change of the results.

Figure 1. Approximate display of the best results in the "statics" discipline, in the period from 2002 to 2021, according to the equation of the polynomial regression analysis of the first degree.
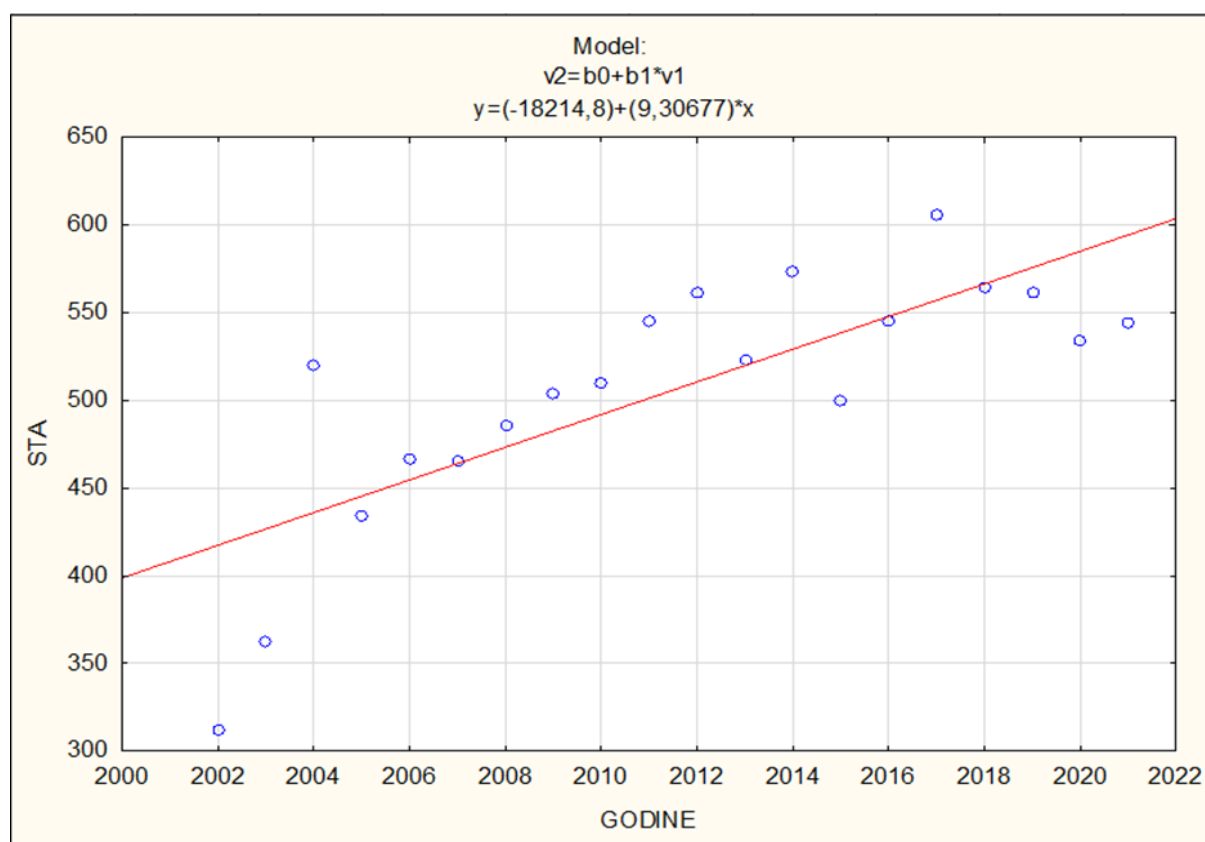

Model:
$v2 = b0 + b1*v1$
$y = (-18214,8) + (9,30677)*x$

Table 2. The statistical processing of the best results in the "statics" discipline, in the period from 2002 to 2021.

STA	Multiple R	R²	b		p
Polinom			b0	-18214.8	0.00
Years	0.77	0.60	b1	9.3	0.00

Legend: Multiple R - correlation coefficient, R² - coefficient of determination, b - regression coefficient, p - statistical significance.

Table 3 shows the three best results in the discipline "dynamics with flippers" in the period from 2002 to 2021. According to the collected data, the best result was achieved in 2019 at the European Championship held in Istanbul, Turkey.

Table 3. List of the three best results, expressed in meters, in the "dynamics with flippers" discipline, by year and with their descriptive statistics.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.	109	153	163	156	207	244	250	233	265
2.	109	122	157	142	162	234	222	226	257
3.	106	122	157	140	162	226	215	207	244
A.S.	108.0	132.3	159.0	146.0	177.0	234.7	229.0	222.0	255.3
ST.DEV.	1.73	17.90	3.46	8.72	25.98	9.02	18.52	13.45	10.60
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1.	273	249	232	288	294	300	279	279	316
2.	261	232	228	275	277	285	275	265	284
3.	251	228	227	269	265	273	267	259	276
A.S.	261.7	236.3	229.0	277.3	278.7	286.0	273.7	267.7	292.0
ST.DEV.	11.01	11.15	2.65	9.71	14.57	13.53	6.11	10.26	21.17
	2020	**2021**							
1.	269	278							
2.	266	264							
3.	260	265							
A.S.	265.0	269.0							
ST.DEV.	4.58	7.81							

Legend: A.S. - arithmetic mean, ST. DEV. - standard deviation.

By analyzing the data from Figure 2, intervals of decline, stagnation and growth of the results can be observed over the years, while the best result was achieved in 2019. The coefficient of determination in Table 4 shows a strong positive correlation of the results, and further analysis established statistical significance based on the constant change in the results.

Table 4. The statistical processing of the best results in the "statics" discipline, in the period from 2002 to 2021.

DYN	Multiple R	R²	b		p
Polinom			b0	-16310.4	0.00
Years	0.87	0.77	b1	8.2	0.00

Legend: Multiple R - correlation coefficient, R² - coefficient of determination, b - regression coefficient, p - statistical significance.

Figure 2. Approximate display of the best results in the the "dynamics with flippers" discipline, in the period from 2002 to 2021, according to the equation of the polynomial regression analysis of the first degree.

Model: $v3=b0+b1*v1$
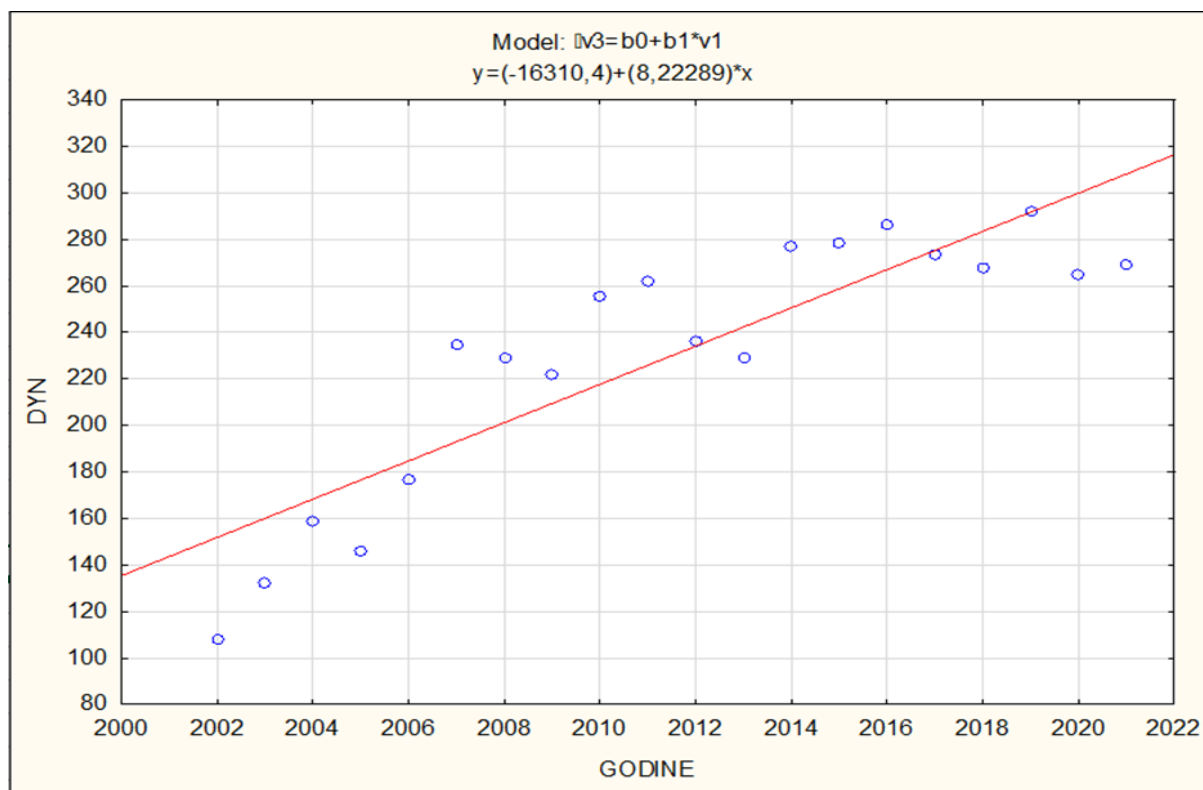$y=(-16310,4)+(8,22289)*x$

Table 5 shows the list of the three best results in the discipline "dynamics without flippers" in the period from 2002 to 2021. The best result in the mentioned discipline was 240 meters, achieved in 2019. Figure 3 presents a graph of the results achieved in the period from 2002 to 2021 in the discipline "dynamics without flippers", arranged according to the equation of the first-degree polynomial regression analysis. A significant increase in results was recorded in the period from 2006, after which the value grew linearly until 2012. After the drop in results in 2012, there was predominantly an increase in results, with smaller intervals of decline, until the best result was achieved in 2019. The coefficient of determination in Table 6 shows a strong positive correlation of the results, and statistical significance was established because it shows constant changes in the results.

Table 5. List of the three best results, expressed in meters, in the "dynamics without flippers" discipline, by year and with their descriptive statistics.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.	81	93	106	109	176	175	213	232	218
2.	81	88	104	106	139	155	175	166	200
3.	75	83	100	105	131	151	165	158	175
A.S.	79	88	103	107	149	160	184	185	198
ST.DEV.	3.46	5.00	3.06	2.08	24.01	12.86	25.33	40.61	21.60
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1.	207	200	206	226	203	211	215	208	240
2.	200	180	188	213	200	209	205	206	234
3.	196	179	184	205	200	208	201	203	236
A.S.	201	186	193	215	201	209	207	206	237
ST.DEV.	5.57	11.85	11.72	10.60	1.73	1.53	7.21	2.52	3.06
	2020	**2021**							
1.	229	204							
2.	225	226							
3.	218	200							
A.S.	224	210							
ST.DEV.	5.57	14.00							

Legend: A.S. - arithmetic mean, ST. DEV. - standard deviation.

Figure 3. Approximate display of the best results in the "dynamics without flippers" discipline, in the period from 2002 to 2021, according to the equation of the polynomial regression analysis of the first degree.
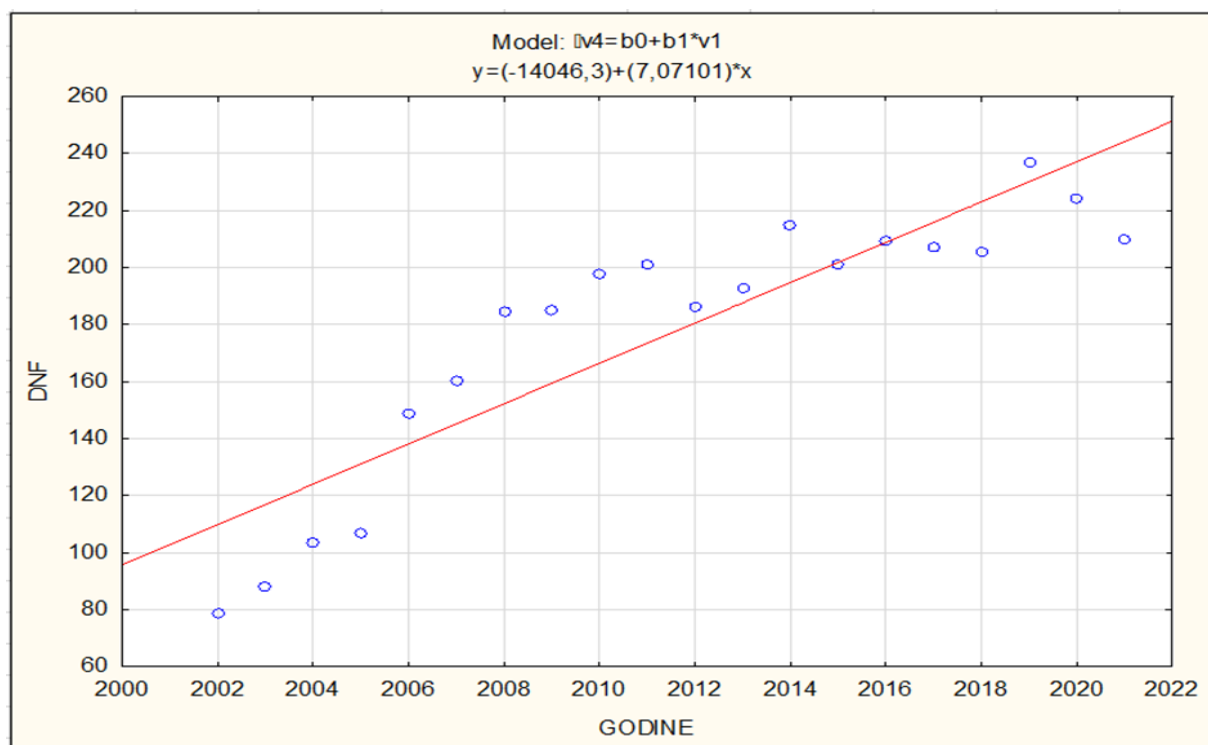
Table 6. The statistical processing of the best results in the "dynamics without flippers" discipline, in the period from 2002 to 2021.

DNF	Multiple R	R²	b		p
Polinom			b0	-14046.3	0.00
Years	0.90	0.80	b1	7.1	0.00

Legend: Multiple R - correlation coefficient, R² - coefficient of determination, b - regression coefficient, p - statistical significance.

DISCUSSION

According to the data obtained from the research, a linear increase in results in all three disciplines (statics, dynamics without flippers, dynamics with flippers) between 2002 and 2021 can be determined. The linear improvement of results over the years can be seen through the conducted statistical analysis, however there are variations in certain years where there is stagnation, decline or a sudden increase in results. In the discipline of statics, the progress of the results is clearly visible (Table 2), but already in 2004, a sudden improvement of the results can be noticed. The sudden improvement in results can be confirmed by the exponential growth of scientific research in the field, for example, the "Handbook of Freediving" by Umberto Pelizzari and Stefano Tovaglieri has become part of the basic literature in the sport of freed apnea diving. In addition to the above, Dujić et al. (2013) conducted plentiful research in the field of apnea diving, studying the principles of action and consequences of apnea diving on the human body as well as techniques for preparing the body for immersion. In addition, there is a lot of literature that emphasizes the importance of fitness preparation for achieving results and success in competitive apnea diving (Drviš, 2012). At the same time, that year, the German apnea diver Tom Sietas achieved unattainable results for other competitors and set a new AIDA world record. Between 2005 and 2017, there is a clear constant increase in results, with a decrease in results in 2013 and 2015 (Figure 1). Snorkeling is a relatively young sport that is continuously growing in popularity. From this progressive improvement of the results, it can be concluded that the human limits in apnea diving have not yet been reached. Technically innovative equipment and the discovery of new training techniques combined with the growing popularity of this sport, leads to the conclusion that the results will continue to improve in the coming years (Pelizzari, Tovaglieri, 2004).

Analyzing the development trend of the three best results in the dynamics with flippers pool discipline in the 2002 to 2021 period (Table 3, Figure 2), an exponential improvement of results is visible. The best result of 316 meters, in the discipline of dynamics with flippers, was achieved in 2019. In the last two decades, competitive apnea diving has shown great progress. For example, from 12 men's and women's world records that were achieved in the six main competitive disciplines in January 2009, only three remained unchanged the following year. The main problem with divers is whether the safety measures implemented during training and competition can keep up with human limits in the length, depth and duration of the dive (Schagatay, 2010). Patrician et al. (2021) emphasizes that it is important to understand the factors that determine the breath-holding period: besides the extreme interest in human physiology, as well as in the preparation of athletes for apnea competitions, it is important to know the safety and medical points of view in order to improve the rules within the AIDA and CMAS organizations.

Exploration of the results in the discipline of dynamics without flippers in the period from 2002 to 2021 shows a continuous improvement of the results, which can also be explained by the fact that over the years this sport has become a common subject of research, arousing the interest of scientists by breaking through both physiological and psychological assumptions about human abilities. By analyzing the trend of competition results, it can be concluded that there has been a big shift forward in the last 20 years (Table 6; Figure 3). In apnea diving, a sport that does not depend so much on technological innovations, but on human physiological and psychological characteristics, the limitation of energy consumption is more important than speed. Preparation before the competitions itself has also changed over the years, and is equally important for a good result. Previous research shows that different preparation strategies can be used before diving, but there is no "recipe" that promises good results. A few years ago, the standard warm-up consisted of immersion and various breathing techniques, in comparison to more recently where a method without warm-ups and breathing exercises before the competition is common. Top divers also started using this newer strategy (Schagatay, 2010). For example, one of the breathing exercises before diving is described by Patrician et al. (2021:2), saying that most divers practice lung-packaging - glossopharyngeal insufflation before diving, because performing this preparation "can increase lung volume from 11 to 26 percent". Bouten et al. (2019) conducted an eight-week study where they analyzed the effects and impacts of apnea training. They concluded that the volume of the spleen can be increased using apnea training. Contraction of the spleen is a very important response to acute apnea and causes the release of

red blood cells into the bloodstream. Patrician et al. (2021:5) also discusses the importance of splenic contraction because "hemoconcentration via splenic contraction would increase CO2 (assuming all else remains equal) by ~5%, which may provide a protective benefit immediately after emergence to avoid hypoxic loss of consciousness". In addition, the spleen has been used as a site for additional storage of red blood cells in a large number of mammals. In humans, marine mammals and some endurance runners such as horses, this storage capacity can be called upon when increased oxygen transport is required. Spleen contraction in humans was first described in Ama divers and is induced mainly by hypoxia and accompanied by hypercapnia (Richardson, 2008, according to Schagatay, 2014). Lemaître, Joulia and Chollet (2010:413) conducted a study of the physiological effects during apnea training in which elite apnea divers participated, and the results displayed that "the apnea divers showed reduced acidosis, oxidative stress and basal metabolic rate, and also increased values of hepatocytes, hemoglobin mass and lung volume. The results obtained indicate that apnea training can be an effective substitute for hyperbaric or normobaric hypoxia for increasing aerobic and/or anaerobic results".

Snorkeling is a sport that increasing arouses interest among athletes, but also among scientists who research and explain the principles by which it is possible to achieve evidently growing results, which require excellent physiological and psychological abilities. From the very beginnings to the latest results in apnea diving, all the predictions of doctors and experts in static apnea, long-distance diving and reachable depths have been surpassed. The results of the research showed a progressive growth of results over the years, with occasional intervals of stagnation and decline. Constant progress of results in competitive apnea diving in all three disciplines was recorded (Figure 1, Figure 2, Figure 3).

It is assumed that the evolution of this sport and the exponential growth of literature in the field of apnea diving has resulted in a significant, continuous increase in results. According to the analyzed literature, an important success factor is the knowledge of certain physiological properties, the physical condition of the individual and the optimization of energy. In addition to the above, it is extremely important to carry out adequate preparation and maintain good physical condition in order to reduce the possibility of injuries and avoid long-term health consequences. In order to determine the exact factors that influenced the improvement of the results, it is necessary to carry out more detailed analysis that include preparations before diving, training methods and other factors that can affect the achievements of apnea divers. According to previous research, there are physiological factors that can affect the time a diver

spends under water, such as lung capacity, spleen size, etc. Considering the trend of growth in results in the last twenty years and new methods of training as well as preparation of athletes before diving, we can expect this trend to continue in the coming years.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

Alkan, N., Akış, T. (2013). Psychological characteristics of free diving athletes: A comparative study. International Journal of Humanities and Social Science, 3(15), 150-157.

Bouten, J., Caen, K., Stautemas, J., Lefevere, F., Derave, W., Lootens, L., ... i Boone, J. (2019). Eight weeks of static apnea training increases spleen volume but not acute spleen contraction. Respiratory physiology & neurobiology, 266, 144-149. https://doi.org/10.1016/j.resp.2019.04.002

Drviš, I. (2012). Učinci anaerobnoga intervalnog treninga na natjecateljsku uspješnost u disciplini ronjenja na dah – dinamika (PhD Thesis). Kineziološki fakultet, Zagreb.

Dujić, Ž., Brešković, T., i Baković, D. (2013). Breath-hold diving as a brain survival response. Translational Neuroscience, 4(3), 302-313. https://doi.org/10.1161/HYPERTENSIONAHA.108.127530

Jablonski, J. (2000). Doing it right: The fundamentals of better diving. Florida: Global Underwater Explorers.

Lemaître, F., Joulia, F., i Chollet, D. (2010). Apnea: A new training method in sport?. Medical hypotheses, 74(3), 413-415. https://doi.org/10.1016/j.mehy.2009.09.051

LeRoy, F. (2017). How long can you hold your breath? (Graduate thesis). Digital Commons @RISD. available at: https://digitalcommons.risd.edu/masterstheses/155.

Patrician, A., Dujić, Ž., Spajić, B., Drviš, I., i Ainslie, P. N. (2021). Breath-hold diving–the physiology of diving deep and returning. Frontiers in physiology, 12(639377), 1-11. https://doi.org/10.3389/fphys.2021.639377

Pelizzari, U., Tovaglieri, S. (2004). Manual of Freediving: Underwater on a single breath. Bear Island: Idelson-Gnochi Limited Publishers.

Schagatay, E. (2009). Predicting performance in competitive apnoea diving. Part I: static apnoea. Diving and Hyperbaric Medicine. 39 (2), 88-99.

Schagatay, E. (2010). Predicting performance in competitive apnea diving, part II: dynamic apnoea. Diving Hyperb Med, 40(1), 11-22.

Schagatay, E. (2014). Human breath-hold diving ability and the underlying physiology. Human evolution, 29(1-3), 125-140.

Scherhag, A., Pfleger, S., Grosselfinger, R., i Borggrefe, M. (2005). Does competitive apnea diving have a long-term risk?: cardiopulmonary findings in breath-hold divers. Clinical Journal of Sport Medicine, 15(2), 95-97.