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The Effect of 3 Breathing Techniques on 25 m Freestyle Swimming Performance Level in Swimming Branch

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Abstract

The purpose of the study; It is aimed to evaluate different breathing techniques such as mouth-to-mouth exhale, mouth-to-nose exhale and mouth-to-mouth and nose exhale to determine which one may have more effect on swimming performance. 16 female participants who joined swimming training for 1 year were determined as the study group. This group was called (age 24.44±1.09 years, height 166.06±5.85cm, weight 58.19±3.22 body). The exercise program applied for 120 minutes, for 2 days a week and lasted 8 weeks. There were 4 techniques (freestyle, backstroke, breaststroke, butterfly) with varying movements of each technique, with different breathing methods within each training unit. These breathing methods were mouth-to-mouth exhale (*MM*), mouth-to-nose exhale (*MN*) and mouth-to-mouth and nose exhale (*MMN*). These breathing methods were planned and practiced. Windows Excel and SPSS (Statistical Package for the Social Sciences) 25.0 computer programs were used to analyze the data from the research. Numerical variables are expressed as percentages and mean ± standard deviation. Skewness and kurtosis values were examined to determine whether the data obtained showed a normal distribution or not. In this context, the -2, +2 skewness and kurtosis values determined by George and Mallery (10) were taken into account and it was determined that the distribution was normal. Since the data showed normal distribution, Paired-Sample T test, which is one of the parametric tests, was used to compare dependent variables within groups. One Way Anova test was used for intergroup comparison. The significance level was accepted as ($p<0.05$). When intergroup comparisons before and after training were examined, no statistically significant difference was found between pre-test and post-test values in the MM group regarding possible effects on 25-meter freestyle swimming performances ($p>0.05$). On the other hand, in the intergroup comparisons made in the MN and MMN groups, an improvement of 1.01% and. 99%, respectively, was observed and the differences were found to be statistically significant ($p<0.05$). In the intergroup comparison between the pre-test and post-test values of MM, MN and MMN groups, no statistically significant difference was found ($p>0.05$).

In conclusion; No statistically significant difference was found between 3 different breathing techniques within the training group. In order to reveal this difference, it is recommended to increase and expand the intensity and scope of training time in different studies. Statistically significant differences were found between the pre-and post-test breathing types of inhaling through the mouth (IM), exhaling through the nose (EN), and inhaling through the mouth (IM) and exhaling through both mouth and nose (EMN), thus revealing that they could significantly affect performance.

Keywords: Inhaling and exhaling, diaphragm, stroke, Leg stroke.

Özet

Yüzme Branşında 3 Nefes Tekniğinin 25 m Serbest Teknik Yüzme Performansı Düzeyine Etkisi

Çalışmanın amacı; farklı nefes tekniklerinin ağızdan al ağızdan ver, ağızdan al burundan ver, ağızdan al ağız-burun birlikte ver, hangisinin yüzme performansı üzerine daha etki olabileceğinin tespiti yönünde değerlendirilmesi amaçlanmıştır. Araştırmaya 1 yıldır yüzme antrenmanlarına katılan 16 kadın katılımcı çalışma grubu olarak belirlenmiştir. Bu grup (yaş 24,44±1,09yıl, boy 166,06±5,85cm kilo 58,19±3,22 vücut) olarak adlandırıldı. Uygulanacak olan egzersiz programında 8 hafta boyunca, haftada 2 gün 120 dk. 4 teknik olan (serbest, sırt üstü, kurbağalama, kelebek) her tekniğin değişen diriller içeriğinde hazırlanan programlar, her antrenman birimi içerisinde farklı nefes yöntemleri olan; Ağızdan al Ağızdan ver (AA), Ağızdan al Burundan ver (AB), Ağızdan al Ağız-Burun birlikte ver (AAB) bu nefes yöntemleri planlanarak antrenmanlar uygulatılmıştır. Yapılan araştırmadan elde edilen verilerin istatistiksel analizi için Windows Excel ve SPSS (Statistical Package for the Social Sciences) 25.0 bilgisayar programları kullanılmıştır. Sayısal değişkenler, yüzde ve ortalama ± standart sapma olarak ifade edilmiştir. Elde edilen verilerin normal dağılım gösterip göstermediğini belirlemek için çarpıklık basıklık değerleri incelenmiştir. Bu kapsamda George ve Mallery (10) tarafından belirlen -2, +2 çarpıklık basıklık değerleri dikkate alınmış ve dağılımın normal olduğu tespit edilmiştir. Veriler normal dağılım gösterdiği için, grup içi bağımlı değişkenlerin karşılaştırılmasında parametrik testlerden Paired-Sample T testi, gruplar arası karşılaştırmada ise One Way Anova testi kullanılmıştır. Anlamlılık düzeyi p<0,05 olarak kabul edilmiştir. Antrenman öncesi ve sonrası grup içi karşılaştırmalar incelendiğinde, 25 metre serbest yüzme performansları üzerindeki olası etkiler üzere AA grubunda ön-test ve son-test değerleri arasında istatistiksel olarak anlamlı bir farklılık tespit edilmemiştir (p>0,05). Buna karşın AB ve AAB gruplarında yapılan grup içi karşılaştırmalarda sırasıyla %1.01 ve %.99 gelişme gözlemlenmiş ve elde edilen farklar istatistiksel olarak anlamlı tespit edilmiştir (p<0,05). AA, AB ve AAB gruplarının ön-test ve son-test değerleri arasında yapılan gruplar arası karşılaştırmada ise istatistiksel olarak anlamlı bir farklılık tespit edilmemiştir (p>0,05).

Sonuç olarak; Antrenman grubu içerisinde 3 farklı nefes tekniği arasında istatistiksel olarak anlamlı bir fark bulunamadı. Bu farklılığı ortaya koyabilmek için antrenman süresi şiddeti ve kapsamının farklı çalışmalarda arttırılması ve genişletilmesi önerilmektedir. Nefesi ağızdan al burundan ver ve ağızdan al ağız burun birlikte nefes ver nefes tipinin ön ve son test arasında istatistiksel olarak anlamlı farklılıklar bulunmuştur böylelikle de performansı önemli ölçüde etkileyebileceği ortaya koyulmuştur.

Anahtar Kelimeler: Nefes alıp verme, diyafram, kulaç, bacak vuruşu.

INTRODUCTION

Swimming is a versatile sport that requires a unique blend of strength, endurance and technical abilities. Optimum performance depends on the harmony and systematic functioning of these functions, like musculoskeletal, cardiovascular and respiratory systems. A delicate balance between aerobic and anaerobic energy production requires the ability to maintain effective and efficient striking mechanics under conditions of fatigue and environmental stress (35). Swimming is one of the best exercises to maintain physical fitness. It has a profound effect on the individual's lung function (29), and it is thought that emotional and mental factors also play a major role and can positively affect the performance of individuals at a significant level (37, 26). Since swimming is a sport performed intermittently, both breathing pattern and breathing frequency are important. Swimming exercises make almost all muscle groups work. Therefore, the usage of O_2 for muscle is higher in swimmers. Water pressure applied to the chest makes breathing difficult. The amount of breathing a swimmer does during different strokes varies from stroke to stroke. Lung function status plays an essential role in swimming performances (15), and is considered a sports branch in which physiological requirements can lead to lung adaptations (4). In general, swimming coaches recommend 'hypoxic exercises' which involve holding the breath for approximately 7-10 footstrokes of the individual's total lung capacity (TLC) and then holding the breath for a prolonged period before breathing in again. Such controlled frequency breathing during swim training can cause more hypercapnic than hypoxic effects (42). It is generally accepted that these trainings can increase the fatigue resistance of respiratory muscles over time, which can lead to improved swimming duration (4). The traditional method used in performance swimming is to take the head out of the water while underwater and breathe in through the mouth and exhale through the nose in a short time. Thus decreasing the resistance emerged by turning the head but because of the increase in exhalation, helping to overcome the resistance of the water, there is a rise in fatigue of the respiratory muscles. Moreover, there is a decrease in blood flow and oxygen supply to other exercising muscles (12). Swimming at a competitive level requires a serious and purposeful organization of the breathing technique in order to achieve maximum oxygen utilization levels in a relatively short period of time. Techniques developed to improve performance and overcome swimming-related complications focus on keeping the lungs in good condition, increasing vital capacity, regulating respiratory functions and strengthening the respiratory musculature (12). The respiratory function plays a fundamental physiological role in human physiology by providing and its relationship with athletic performance, especially in swimming, has received relatively little attention in performance studies (43). Given the mountainous activity performance, methods that include cyclic hypoxia, time loading, stroke technique, patterns dictated by the position of the body in the water are important (7, 1). Specifically, the muscles involved in respiratory mechanics, particularly those associated with inhalation, such as the intercostal muscles and diaphragm muscle, may have an influential role in athletic performance, given their role in exercise tolerance (22).

Correct breathing during swimming provides the speed of movement in the distance the swimmer will swim and expresses the distance the swimmer must complete. The individual's general condition and fatigue level are important when breathing during swimming. Wrong breathing during trainings can cause a serious problem that leads to disabilities. When an athlete starts training in water, it depends on his ability to control his breathing while swimming and to perform the movements he needs to display with the correct technique. Correct breathing technique in swimming is an important process during the swimmer's training period. In order to make athletes successful in teaching swimming, the compatibility of correct breathing technique and swimming techniques is important. If an individual wants to learn swimming, s/he must first learn to breathe correctly. A swimmer that has learned how to breathe in the right way can master every kind of swimming techniques (39). When swimming is performed at a competitive level, increased breathing causes fatigue in the muscles that contribute to respiration, reducing breathing frequency, endurance and performance during swimming (20). Studies have reported that serum lactate during swimming causes muscle pain and stiffness as a metabolic byproduct of the glycolytic pathway (12). The traditional method of competitive swimming performance is to breathe in through the mouth and out through the nose as quickly as possible while moving through the water, and to reduce the resistance that occurs when turning the head to the right and left. Thus, depending on the increase in exhalation, which helps to cope with water resistance that will affect performance; Respiratory muscle fatigue may decrease oxygen transport and blood flow to other muscle groups, which contribute to swimming performance. During high-level swimming, the breathing technique must be well regulated in order to provide maximum oxygen demand in a short period of time. (12). Techniques developed to have the best performance and avoid swimming-related complications focus on keeping the lungs in good condition, increasing vital capacity, regulating respiratory activity, and strengthening the respiratory musculature (20). The breathing technique used during exercise is also very substantial within the scope of the exercise. Here, changes in blood pressure are also seen when the athlete inhales, exhales or holds his breath. During exhalation or breath holding, the load on the heart and blood pressure increases. On the other hand, breathing may also reduce intrathoracic pressure during resistance exercise and contribute to reducing the increase in blood pressure (21). Correct breathing helps carry enough oxygen to the tissues and enable better activity (27). The main purpose of breathing exercises is; to increase relaxation and respiratory efficiency (3). Breath is necessary for life, as well as for protection from diseases, improvement of quality of life, and health and energy balance. Additionally, with the correct breathing technique, oxygen consumption can increase by 20% during exercise or sports activities (6).

People generally change their breathing from nose to mouth as the *'amount of air inhaled per minute'* increases above 40 L/min (30). The breathing cycle rises from approximately 40% of maximum intensity resting values (E being slightly longer than I) to 50% *'equal inhalation and exhalation*' or higher (26, 18, 32). Shorter *'exhalation time'* and *'breathing time'* mean that the the mean inspiratory flow rate (air flow rate during the breathing phase) to maintain a constant *'lung function volume* (%)'. Exercise-related *'amount of air breathed per minute*' and energy increases trigger changing respiratory pump muscular system activity and coordination. From rest to 70% of maximum workload, diaphragmatic pressure doubles or even more and is accompanied by increased shortening rate, contributing 70%-80% of the total inspiratory force (40). As fatigue increases during swimming, the active exhalation (expiratory muscle activation) reduces the lung volume at the end of expiration (exhalation) and decreases the inspiratory workload (inhalation). Reach voluntary contraction at 50% of their maximally intense contraction level (2,13). Intercostal muscles, parasternal muscles, scalene muscles and neck muscles measure *'lung volume after-inspiratory'* and raspiratory diameter, e.g. it contributes to ventilation at high intensities by regulating dilation and inflammation. In general, the ventilation pump and diaphragm muscle involved work systemically very efficiently In total, the diaphragm and associated ventilation pump musculature is highly efficient [~3%-5% total O2 consumption (VO_2max)] and Resistant to fatigue factor at swimming intensities below submaximal fatigue resistant at densities below the maximum (41, 33). The arm and leg muscles; respiratory frequency, as well as respiration being coordinated with stroke rate (5). Furthermore, effective stroke mechanics require minimizing the duration of inspiration. Tidal volume increases proportionally with respiratory frequency restriction (36). For this reason, inspiration must be rapid in order to maintain ventilation per minute at a level that meets metabolic demand (14). Swimming requires a sequential breathing system as well as stroke efficiency and buoyancy. During swimming, the respiratory system is synchronized with the movement system of the limbs, requiring a demanding breathing phase within the biomechanical constraint of the foot stroke cycle. Sequential breathing can have a significant effect on tidal volume and respiratory frequency, which can lead to varying degrees of hypercapnia and hypoxemia (19). During the stroke phase while swimming, exhaling is done when the face is under water and therefore the breathing technique must be consciously controlled. Buildup in the expiratory muscles. Additionally, prone body position can cause changes in blood perfusion, capillary recruitment, and respiratory function that also affect lung function (18). The aquatic environment has been found to pose ventilation, including frequent breath holding, ribcage submergence, and prone body positioning. Lung volume and other factors such as the impact of stroke efficiency on metabolic work. Considering these difficulties, it can be assumed that the work of breathing will be higher during swimming compared to land exercises, thus increasing the for working respiratory muscles (19). It can also be said that water has a compelling and powerful effect on breathing and that 'the energy used to cover a targeted distance is equivalent to 4 times the energy to run the same distance' (32). Considering the challenging effect of the amount of oxygen required for muscle movements during exercise on the breathing mechanism on performance, it can affect the speed of both training and competitive level. The aim of the present study is to evaluate different breathing techniques (such as both MM, MN and MMN) to determine which one may have more effect on swimming performance.

METHOD

Research Group

16 female participants with an average age of 24.44±1.09, who have been participating in swimming training for 1 year, were determined as the study group. All participants completed and approved the voluntary consent form declaring that they were volunteers for the research. The purpose and importance of the study was explained to the participants, and their motivation and desire levels were increased. The 25 m free technical distance to be swam was practiced two days a week before the experiment at the Bingöl Youth and Sports Provincial Directorate Indoor Swimming Pool. Demographic information of the participants is presented in Table 1.

Table 1. Demographic characteristics of the research group

Variables	n	$\bar{X}$	Ss
Age (years)	16	24,44	1,09
Height (cm)	16	166,06	5,85
Weight (kg)	16	58,19	3,22

Data collection tools

Height: The subjects held their breath, without shoes, heels and big toes of both feet together, standing upright on a flat surface, the degree of precision was measured with a 0.01 m. stadiometer (SECA, Germany).

Weight: Subjects were measured with an electronic scale (SECA, Germany) with a precision of 0.1kg, wearing sportswear (T-shirt, tracksuit) and without shoes.

25 m Freestyle Technical Swimming Times: The participants' 25 m freestyle technical swimming times were determined using the "Selex Slx 508 chronometer (30 Lap)" brand chronometer.

Inhaling and exhaling through mouth (MM) Swimming Degrees: Starting from free technical swimming in the water, the breathing cycle by breathing in through the mouth outside the water and exhaling through the mouth in the water was completed for 25 m.

Inhaling through mouth and exhaling through nose (MN) Swimming Degrees: Starting from free technical swimming in the water, the breathing cycle of inhaling through the mouth outside the water and exhaling through the nose in the water was completed for 25 m.

Inhaling through mouth and exhaling through both mouth and nose (MMN) Swimming Degrees: The breathing cycle is completed by starting free technical swimming in the water, breathing in through M outside the water, and exhaling through MN in the water was completed for 25 m.

Training protocol

Three different breathing techniques were explained to the 16 female participants. They continued their swimming training for 1 year. One week before the first training unit, the types of breathing techniques added to the exercise content that they will practice for 8 weeks were shown one by one, mistakes were corrected and opportunities were provided for them to practice the breathing techniques as desired. In the exercise program to be applied, 120 minutes, 2 days a week for 8 weeks. The programs, which are prepared with 4 techniques (freestyle, backstroke, breaststroke, butterfly) with varying movements of each technique, are given to the participants at the beginning of each training unit for the first 15 minutes to increase body temperature and blood circulation. Training started with warming up in water and lasted 95 minutes. The training content continued as the main phase, with breathing techniques changing within the specified technical movements within the specified distances, 10 minutes and completed it with cooling exercises. There are different breathing methods within each training unit. These breathing methods: Inhaling and exhaling through mouth (MM), Inhaling through mouth and exhaling through nose (MN), Inhaling through mouth and exhaling through both mouth and nose (MMN). They were planned and practiced. Five minutes of passive rest was provided between each phase. The intensity in the 25 m free technique swimming test that the subjects swam for each breathing method was determined by the target heart rate according to the heart rate reserve (Karvonen) method. As a result of a 10-second heart rate count from the carotid artery in the neck immediately after the end of the exercise (9).

Karvonen Method; HRmax=220-Age, HRR=HR max-HR rest, 60% THR=(0.60xHRR)+HR rest (9).

Statistical analysis

Windows Excel and SPSS (Statistical Package for the Social Sciences) 25.0 computer programs were used for statistical analysis of the data obtained from the research. In the research, firstly, the blank space was evaluated to check the suitability of the analyzes and the assumptions. As a result of this process, the data of three participants who were filled in incorrectly and incompletely were excluded from the analysis and analyzes were made on the data of the remaining 16 participants. Numerical variables are expressed as percentages and mean ± standard deviation. Skewness and kurtosis values were examined to determine whether the data obtained showed a normal distribution. In this context, the -2, +2 skewness and kurtosis values determined by George and Mallery (10) were taken into account and it was determined that the distribution was normal. Since the data showed normal distribution, Paired-Sample T test, one of the parametric tests, was used to compare dependent variables within groups, and One Way Anova test was used to compare between groups. The significance level was accepted as $p<0.05$.

Ethical approval and institutional permission

This research was found ethically appropriate by the Bingöl University Health Sciences Scientific Research and Publication Ethics Committee 'Decision:2) dated 07.05.2024, numbered 24/10'.

FINDINGS

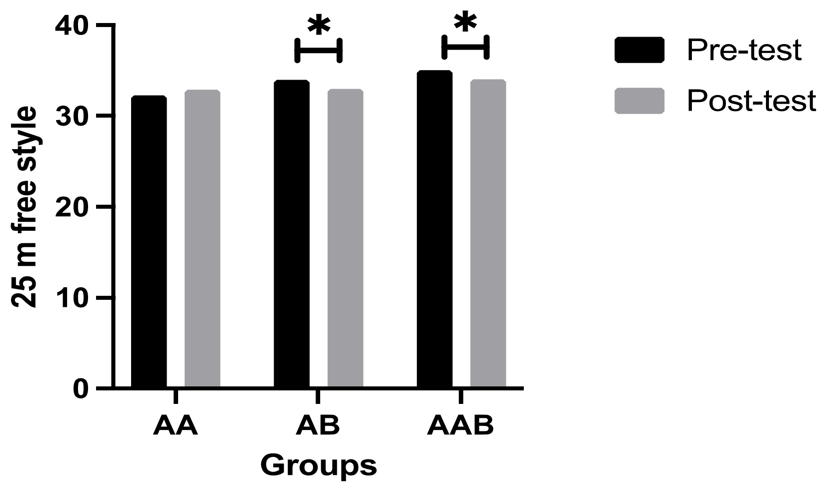
The research was conducted to evaluate the possible effects of three different breathing techniques for eight weeks on the 25-meter free swimming performance of subjects who participated in swimming training for a year.

As seen in Table 2, there was not any statistically significant difference between the pre-test and post-test values in the MM group (p>0.05). On the other hand, in the intragroup comparisons made in the MN and MMN groups, an improvement of 1.01% and .99%, respectively, was observed and the differences were found to be statistically significant (p<0.05). In the intergroup comparison between the pre-test and post-test values of MM, MN and MMN groups, no statistically significant difference was detected (p>0.05).

Table 2. Comparison of participants' 25 m freestyle swimming degrees within and among the groups

Variables	Groups	n	Within Groups			Among Groups	
			Pre-test X±Ss	Post-test X±Ss	*p*	*F*	*p*
25 m Free Style Technique	MM	16	32,30±6,10	31,92±5,89	,122	1,076	,350
	MN	16	33,98±6,59	32,97±6,68	**,027***		
	MMN	16	35,04±6,99	34,04±6,67	**,016***		

*$p<0.05$. MM: Inhale through mouth and exhale through mouth, MN: Inhale through mouth and exhale through nose, MMN: Inhale through mouth and exhale through mouth and nose.



Graph 1: Effect of participants' MM, MN and MMN breathing techniques on their 25 m free swimming degrees **p<0.05.*

DISCUSSION AND CONCLUSION

This study was carried out to determine which of the different breathing techniques such as MM, MN and MMN techniques would be more effective on swimming performance. 16 female participants, with an average age of 24.44±1.09, trained for 120 minutes, 2 days a week and lasted for 8 weeks. There are 4 techniques in swimming training (freestyle, backstroke, breaststroke, butterfly) and the programs are prepared with the changing movements of each technique, with different breathing methods within each training unit. The breathing methods are as follows MM, MN and MMN. These breathing methods were planned and practiced.

Murlasits et al. (24) conducted a study to determine the responses of young competitive swimmers to the 200 m swimming test, which increased with different breathing patterns. 8 male swimmers with an average age of 15±2 underwent a 7x200 meter progressive swimming test performed with two different breathing rates. 1; breathing every third beat (BR3) 2; the test was performed twice, 14 days apart, with two different respiratory rates in random order, breathing every five beats. When the performance values are examined, *stroke speed* increased gradually from the first to the seventh series, in agreement with the swimming speed showing the main effect in terms of time (p=0.000). However, the time-dependent condition interaction was not found to be statistically significant (p=0.701). In another study that Lavin et al. (18) conducted to examine the effects of controlled frequency breathing (CFB) swimming on respiratory function with 18 male swimmers between the ages of 18-45, who completed each distance of 16x25 meters within 45 seconds, 3 times a week for 4 weeks, and completed each distance within 45 seconds in the first 8 of 16 swimming strokes. 1 of them were made in a controlled frequency style and the last 8 were made in a beat harmonic style. For the controlled-frequency breathing condition, they were instructed to inhale nearly maximally, hold their breath for approximately two-thirds of the distance, and slowly release air through their nostrils for successful completion of the distance. After 2 weeks of training, the time interval was reduced to 40 seconds. 12 training distances were completed in which controlled frequency breathing (CFB) subjects took 2 breaths per length and beat matched (SM) subjects took 7 breaths per length (18). Increases in the exhalation rate are observed in swimming training performed in a controlled breathing and stroke-synchronous manner. Controlled and harmonious breathing exercises can also increase performance in the swimming distance, which is parallel to the results of our study. Turning the head to breathe can potentially affect hydrodynamic resistance and therefore affect performance. Respiratory restriction can contribute to fatigue. It is more important to breathe adequately for a long time. Since there are distances where aerobic demand is greater, restricting oxygen delivery is expected to alter performance (24).

Hakked et al. (12) conducted a study to examine the effects of yoga breathing practices on swimmers' lung functions and included 27 participants between the ages of 13-20, with 8.29±2.9 in individuals who have been swimming, who did 9.58±1.81 km swimming training every day. Competitive swimmers (13 men and 14 women) participated. Yoga bellow breathing Hole Breathing exercises were applied. Significant improvement in maximum voluntary ventilation (p1⁄4 0.038), forced vital capacity (p1⁄4 0.026) and number of beats per breath (p1⁄4 0.001) in the YBP group compared to the control group. They suggested that YBP helps increase respiratory endurance in competitive swimmers. In the present study, an improvement of 1.01% and .99% was observed in the intra-group comparisons made in the MN and MMN groups, respectively, and the differences were found to be statistically significant *(p<0.05)*. It is parallel to the results of the study that MN and MMN simultaneously, with a longer nasal exhalation time, positively affects performance.

Jakovljevic and McConnell (14) examined the prescan swimming in the first 4 months of the year in 10 college swimmers with an average age of 21.2±1.9 years who had been swimming for 8.2±2.1 years. In their study to evaluate the swimmers, the swimmers performed a 200 m pre-scan swim with reported breathing rates at 90% of race speed: 1; 1 breath (B2) and 2 on every second stroke; 1 breath on every fourth stroke (B4). Maximum inspiratory pressure (PImax) decreased by 21% after B4 and 11% after B2 compared to baseline (p<0.05). 1⁄2La was 15% lower after B4 than after B2 *(p<0.05)*. There was no significant difference between HR, B2 and B4. In another breathing cycle study, Key et al. (16) conducted 22 female swimmers aged (19.0±1.1), performing a maximum effort 100 m swimming test, one with a normal breathing (NB) pattern (1 breath every 2-3 strokes) and the second with controlled frequency breathing (Using the CFB) model (1 breath every 7 beats), post-exercise heart rate increased significantly (p=0.02) higher in the NB trial (184.9±12.0 bpm) than in the CFB trial (174.8±14.8 bpm). NB 100 m swimming average was 60.23±0.53 sec and CFB trial average was 61.36±0.62 sec (p>0.05). In the study of Burtch et al. (4), 25 male and female swimmers aged 18-22 were divided into 2 experimental (CFB) and control groups (stroke compatible), training lasted approximately 35 minutes, 4 days a week, for 4 weeks, and the swimmers breathed every 7-10 strokes. Controlled frequency breathing (CFB)) and one breathing every 3-4 strokes (control group) were allocated and the training content was 8-10 breaths at 50 m (control group) and 2-3 breaths at 50 m (control group). CFB group and 12x50 m were recreated for 5-6 weeks (16 sessions). The CFB group limited their breathing to 2 breaths per round, approximately 24 breaths per workout. The control group was asked to breathe in rhythm with the beat, breathing every 2-3 beats and reaching 10-12 breaths per round. Swimming performance, aerobic capacity, pulmonary diffusion capacity and running economy did not improve after training in both groups (p<0.05). In conclusion, CFB exercise appears to prevent inspiratory muscle fatigue; however, no difference was found in performance results. Jakovljevic and McConnell (14) reported that there was a significant level of inspiratory muscle fatigue after high-intensity swimming. However, inspiratory muscle fatigue is further increased when respiratory frequency decreases during high-intensity front crawl swimming. It has been suggested that respiratory muscle training should be used to enhance its strength in swimmers (14).

In the study of Stavrou et al. (34), the aerobic training period of 10 fin swimmers with an average age of 15.8±0.5 was 8 hours a week, including 8x25 m freestyle leg strokes, and their training age was 7.8±1.8 years, using three different breathing techniques. As a result of the study carried out on the effect of submaximal freestyle leg kick (normal breathing (NB), breath holding (BH) and intermittent breath holding (IBH)), respiratory showed lower SpO_2 values immediately after the end of the IBH technique in relation to the IBH techniques (IBH: 88%±0.9%; BD: 93.3%±0.7%; NB: 98.3%±0.3%; p<0.001). In a similar study that McCabe et al (23) conducted with 10 male competitive swimmers with an average age of 18±2.6 swam two 25 m sprints. When the breathing (Br) group that breathed towards their preferred side compared to the nonbreathing (NBr) group, the swimming speed was found to be substantial higher. When compared to other breathing techniques, HR was higher after IBH (IBH: 177±4.2 bpm-1; BH: 165.7±7.9 bpm-1; NB: 158.3±2.2 bpm-1, p<0.001) and higher PImax after IBH compared to the other two techniques (IBH:168.3±5.3 cmH_2O; BH:166±11 cmH_2O; NB:161.7±11.4 cmH_2O; p<0.05) result was reached. Formosa et al. (8) studied 20 elite swimmers, 10 males, 21.3±3.1 years old, and 10 females, 21.3±3.1 years old. Similarly, in the non-breathing condition, there was a significant difference between breathing and non-breathing values in the footstroke cycle when the symmetry index of net propulsion force was used for the minimum (P=0.035) and maximum (P=0.011) net propulsion force (P=0.011). Using the symmetry timing index within the conditions of not breathing (P<0.001) and breathing (P=0.002), significant differences were detected between not breathing and breathing in the foot strike cycle. Psycharakis and McCabe (28) conducted two maximum 25 m preliminary survey trials with 12 professional male swimmers, with an average age of 18.9±2.4, one without breathing and the other breathing towards the preferred side. In the breathing trial, swimming speed was observed to be significantly slower (p<0.01). Swimmers rotated their hips and shoulders more towards the inhaled side during breathing compared to the uninhaled side during the trial (SR: p<0.01; HR: p=0.03). However, no significant difference was found between these studies in terms of SR and HR. In the breathing trial, SR was significantly higher on the breathing side than on the non-breathing side (p<0.01), but there was no significant difference in HR (p=0.07). There was no evidence that temporal characteristics of HR or SR were related to performance levels in swimming. When the studies are examined, a higher performance on the breathing side compared to non-breathing side and an increase in heart rate were observed in breath holding and intermittent breath holding groups compared to normal breathing. The study of Stavrou et al. (34) supports that it increases acutely. They reported that in these athletes, and in this study, the results were parallel to the studies in which three different breathing exercises positively affected the performance.

Gray et al. (11) carried out a study with 7 female swimmers to examine the effects of 30 sec and 2 min deep breathing exercises on 50 m and 100 m freestyle performance. After deep breathing for 30 seconds (DB30) and 2 minutes (DB2), swimmers performed 50 m and 100 m freestyle sprint swimming under normal conditions (DBNO). However, both in the 50 m freestyle (50 freestyle: DBNO 28.45±1.90 sec vs DB30 28.18±1.59 sec, (p>0.23)) and 100 freestyle (100 freestyle Faster swimming times were observed: DBNO 61.73±4.33 sec versus DBNO 61.73±4.33 sec. DB30 61.54±5.11 sec p=0.79) After DB30, DB2 resulted in slower swim periods in both 50 and 100 m swims compared to DBNO (respectively, DBNO 28.45±1.90 sec, DB2 28 .85±2.21 sec P=0.29; DBNO 61.73±4.33 sec, DB2 62.15±5.52 sec P=0.58). An optional 30-second deep breathing procedure prior to the race resulted in a slight improvement in the time of the 50m and 100m freestyle race, which could potentially turn into a competitive advantage.

Vezos et al. (38) included 10 female freestyle swimmers with an average age of 15±1.2 years and a swimming age of 8.0±1.5 years. In the study, which aimed to determine the effects of breathing on stroke and fathom kinematics in a three-dimensional underwater environment. Each subject performed a series of 25 m prescan trials equal to approximately 80% of their performance under breathing and breath-holding conditions, with a period of 3 min between rests. They reported that breathing during the stroke (t9=2,764; p<0,05) caused significant velocity increases in the displacement of the hand when moving backwards (t9=2,471; p<0,05) and the displacement of the hand towards the side of the body according to the density of the water. In contrast to the X-axis (t9=2,638; p<0,05) during the downward sweep of the arm (t9=2,638; p<0,05), the highest speed of the hand going backward during the sweep of the arm inward (t9=2,368; p<0,05) and the displacement of the hand during the push phase (t9=-2,297; p<0,05), significant decreases were found when breathing was needed. From this point of view, it was concluded that the breathing method during swimming caused significant changes in both basic stroke parameters and general motor trait models due to the coordinated forward progression of the body during breathing.

When the literature was examined, it was seen that there were no detailed studies examining the effects of exercises using different breathing techniques in terms of performance levels. The different breathing techniques in this study were affecting the stroke coordination of the arms and legs in terms of the distance covered by swimmers. It is important to ensure that the *AA*, *AB* and *AAB breathing techniques* is well understood by the athlete. It affects the performance positively in order to minimize the friction effect while progressing on the horizontal plane in the water and to prevent the body from swaying left and right and restricting the forward movement in order to show superiority over its competitors.

No statistically significant difference was found between 3 different breathing techniques within the training group. The aim was to reach a conclusion on which breathing technique can affect performance more significantly. In order to reveal this difference, it is recommended to increase and expand the intensity and scope of training time in different studies. Statistically significant differences were found between the pre- and post-test breathing types, thus revealing that they could significantly affect performance. In most sports branches, the breathing pattern (mouth breathing, rib cage breathing, diaphragm breathing) and the amount of breathing are carried out during technical skill learning to ensure that the learning in breathing techniques is appropriate for the purpose and that the performance development can be demonstrated more healthily. In order to make athletes successful in swimming teaching, the combination of correct breathing coordination and swimming movements must be in harmony. In terms of performance development, it is very important for the athlete and his/her performance to carry the oxygen taken to the relevant muscles to display skill movements for sports branches and control breathing for the respiratory mechanism, cordovascular system and metabolic developments.

Suggestions

The same studies can be done on male athletes. Similar studies can be conducted in different age groups. Underwater cameras can be used to check that the breathing technique is used correctly. In training for coaches and athletes, exercises such as breathing through the mouth and exhaling through the nose and breathing through the mouth and exhaling through both the mouth and nose may be recommended.

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