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A REVIEW ON THE INFLUENCE OF SWIMMING ON POSTURE DEFICIENCIES

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ABSTRACT. Introduction: All sports bring health benefits when practiced correctly, but swimming has, without a doubt, some special features that no other aerobic exercises have, due to the special conditions the aquatic environment requires: the position of the body, the stresses imposed on the body necessary for movement in water (floating, immersion etc.). **Objectives:** Through this study we want to analyze the specialized literature regarding the influence of swimming on body posture and at the same time we wish to observe the effectiveness of posture-correction interventions used and which of them had the best results. **Material and method:** The present study analyzed articles from the following databases: PubMed, Scopus, Google Scholar and ResearchGate published between 2013 and 2022. After applying the inclusion and exclusion criteria, 18 articles were selected for analysis. **Results:** According to selected studies, it was observed that swimming exercises have multiple beneficial effects on the human body, especially in people suffering from various diseases of the lumbar spine. but there are also specialist studies that underline the possible harmful effects on posture. **Conclusions: A**lthough many studies have confirmed the positive effects of swimming on postural deficiencies due to the peculiarities of the aquatic environment, more and more studies have recently emerged that contradict them. According to the latter, it is recommended that swimming should be combined with physiotherapy, therapeutic massage and/or hydrokinetic therapy in order to achieve the desired effects in the treatment of postural deficiencies.

Keywords: *swimming, spine, body posture, children, physical deficiencies, scoliosis, kyphosis, frontal, sagittal plane*

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REZUMAT. Introducere: Toate sporturile aduc beneficii pentru sănătate atunci când sunt practicate corect, dar înotul are, fără îndoială, câteva particularităţi pe care nu le au alte exerciţii aerobice, datorită condiţiilor speciale pe care le impune mediul acvatic: poziţia corpului, solicitările impuse corpului necesare mişcării în apă (plutire, imersiune etc.). **Obiective:** Prin acest studiu dorim să analizăm literatura de specialitate în ceea ce priveşte influenţa înotului asupra posturii corporale şi, în acelaşi timp, să observăm eficienţa diferitelor intervenţii utilizate pentru corectarea posturii. **Material şi metodă:** Au fost analizate articole din următoarele baze de date: PubMed, Scopus, Google Scholar şi ResearchGate publicate între anii 2013 şi2022. În urma aplicării criteriilor de includere şi excludere, au fost selectate pentru analiză 18 articole. **Rezultate:** Conform studiilor selectate, s-a observat că exerciţiile de înot au multiple efecte benefice asupra organismului uman, în special la persoanele care suferă de diverse afecţiuni ale coloanei lombare. dar există şi studii de specialitate care subliniază posibilele efecte nocive asupra posturii. **Concluzii:** Deşi multe studii au confirmat efectele pozitive ale înotului asupra deficienţelor de postură datorită particularităţilor mediului acvatic, au apărut, recent, din ce în ce mai multe studii care le contrazic. Conform acestora din urmă, se recomandă ca, pentru a avea efectele dorite în tratamentul deficienţelor posturale, înotul să fie asociat cu kinetoterapia, masajul terapeutic şi/sau hidrokinetoterapia.

Cuvinte cheie: *înot, coloană vertebrală, postură, copii, deficienţe fizice, scolioză, cifoză, plan frontal, plan sagital*

Introduction

Swimming is recognized as one of the healthiest physical activities, due to the special conditions the aquatic environment requires: the position of the body, the stresses imposed on the body necessary for movement in water (floating, immersion etc.), all these aspects can contribute to a harmonious development of the locomotor system, cardiorespiratory functions and metabolism (Zuzana et al., 2022).

Swimming can be used as an associated means in various therapies, as a utilitarian means, for prophylactic purposes, for recreational purposes or in various sports activities. Regardless of how swimming is used as a motor activity, it influences the body through its demands, contributing to healthy growth and development, to maintaining an optimal morphofunctional status, giving it increased resistance to pathogenic factors (Waller et al., 2014; Zarzeczny et al., 2022).

At the same time, the influence on body posture is determined by practicing swimming regularly through the stress that the locomotor apparatus is subjected to, especially the musculoskeletal system, the joints being freed from the weight of the body (according to Archimedes' principle), the muscular effort being able to be reduced or increased depending on the exercises addressed (Tate et al., 2020; Taşkıran, 2020).

It is worth noting that postural attitude in different individuals is determined by gender, age, state of fatigue, profession and lifestyle. Many people, especially children, suffer from spinal deformities caused by congenital malformations, certain degenerative diseases, spinal trauma, but especially caused by poor posture formed from the childhood (Łubkowska et al., 2014; Stoychevski, 2021).

Objectives

Through this study we want to analyze the specialized literature regarding the influence of swimming on body posture and, at the same time, to observe the effectiveness of various posture-correction interventions used.

Materials and methods

A search of the databases PubMed, Scopus, Google Scholar and ResearchGate was conducted for all publications related to the topic. Only articles published between 2013 and 2022 were searched, and we used the following keywords: swimming, spine, body posture, children, physical deficiencies, scoliosis, kyphosis, frontal, sagittal plane.

The following inclusion criteria were used in order to select the articles:

- to be drafted in English,
- to contain swimming as a means of treating postural deficiencies or to have a comparison between swimming and another form of treatment,

Exclusion criteria:

- the articles that I could not read full-text,
- the articles that did not use swimming as a means of treating spinal conditions.

Results

We identified our records through database search (PubMed, Scopus, ResearchGate and Google Scholar) and found 114 studies. 0 records were found in other sources (newspaper articles). After removing the duplicates, the articles that did not have the full-text available, we screened the remained records for eligibility and removed the articles that did not meet our inclusion criteria. Seventeen records were included in our qualitative synthesis. The main characteristics of the studies are presented in Figure l.

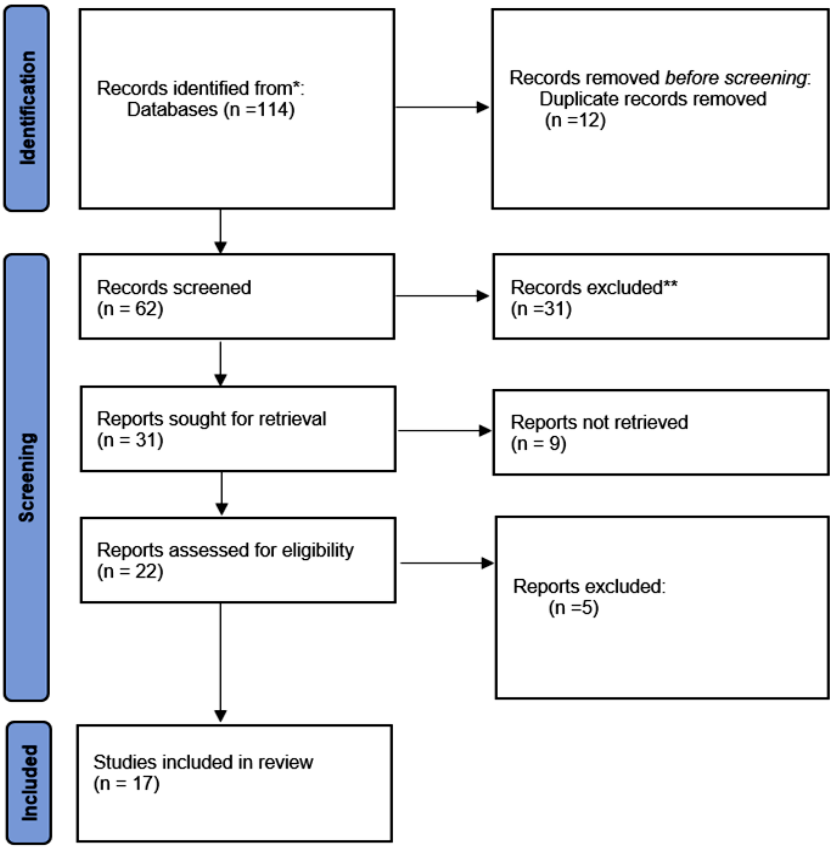

Fig. 1. PRISMA flow chart demonstrating identification, screening and selection of included studies (Page et al., 2021)

Table 1. Main characteristics of the included studies

Author	Title	Participants	Intervention	Results
Torlakovic et al., 2013	Effects of the combined swimming, corrective and aqua gymnastics programme on body posture of preschool age children	50 boys, 5.2±0.6 yrs.	16 weeks, twice a week for 60 minutes.	High level of statistical significance in the variables of shoulder posture assessment (SPA p=.000), overall body posture assessment according to Wolanski (OBPAW p=.000), spinal cord posture assessment (SCPA p=.000),
Barczyk-Pawelec et al., 2012	The influence of exercises in the water on the mobility of the chest and shape in the spine in sagittal plane of children with scoliosis	36 children aged 8–13 years	5 mounts, 3 time/week of swimming	The whole spine length (DCK) and the real length of thoracic kyphosis (RKP) ($p < 0,05$), increased. The angle of inclination of the upper thoracic and the reduction of thoracic kyphosis angle (KKP), were significant, as well.
Karaleic, 2014	Influence of 12 months swimming trainings on postural status of 6-14 year old children	156 children (81 boy and 75 girls), 6-14 years.	12 mounts, 3 time/week.	The number of children with lateral deviations was decreased for 13 (8.33%), of which number of boys was decreased for 5 and number of girls was decreased for 8. Swimming can have positive effect on lateral asymmetry and scoliosis suspected postural status in children
Torlakovic et al., 2014	Evolution of sports-medical team management in the program of posture correction in children	70 girls, aged 11.9±2.3 years	corrective gymnastics, aqua gymnastics and swimming, 28 weeks, 3x1h/week	T-test showed clearly high statistical significance in all variables of posture status, score for shoulders posture (ODRA p=0.000); scapulae (ODLO p=0.000); thorax (OGRK p=0.000); posture of the spine (OKIS p=0.000); abdomen (ODST p=0.000)

Author	Title	Participants	Intervention	Results
Ganciu, 2015	Improving the quality of life of the students with deficiences of the spine, through the program of medical gymnastics and swimming	40 students were divided into two groups including swimming (n = 20) and control (n = 20) group.	combined programs of medical gymnastics and therapeutic swimming, 1 year, 45-60 min/week	pain intensity drops significantly, due therapeutic programs, the decrease being greater than the experimental group (Ott test, schober test, pain intensity p=0,05).
Zaina, 2015	Swimming and Spinal Deformities: A Cross-Sectional Study	112 teens that participate to swimming competitions and 217 students that practice swimming as a free time activity.	The ACS group trained at least 4 (up to 6) times a week for an average of 2-2.5 hours per session. The control group attend physical education classes 3 times a week	Swimming can increase the spinal deformities and Back-Pain conditions. Swimming also increased the risk of hyperkyphosis (OR, 2.26; 95% CI, 1.35-3.77) and hyperlordosis (OR, 2.24; 95% CI, 1.06-4.73), and increased LBP in females by 2.1-fold (95% CI, 1.08-4.06).
Martens et al., 2015	Electromyography in the four competitive swimming strokes: A systematic review	43 studies included	Competitive swimmers	The muscles that most influence the postural and functional aspects are the muscles stressed in freestyle and butterfly style
Folkvardsen et al., 2016	Does elite swimming accelerate lumbar intervertebral disc degeneration and increase low back pain? A cross-sectional comparison	196 students were divided into two groups including swimmers (n = 100) and no swimmer (n = 96), age 19-21	Swimming group: 30 km/week. Control group: 3h/week, physical activities, swimming.	Elite swimmers and controls had similar prevalence of disc degeneration (DD) and LBP, although the pattern of DD differed between the groups. In case of DD, swimmers reported less LBP, although N.S.
Benedek et al., 2017	Correction physical disabilities kyphosis by kinetic means of a sports performance	1 subject	Dynamic exercises for kyphosis, shallow and deep water exercises, 4 mounts, 2 time a week	Swimmers reported less LBP than the no-sport group. However, this was not statistically different (52 vs. 66.7 %, P = 0.41)

Author	Title	Participants	Intervention	Results
Paskaleva et al., 2017	Isometric training and swimming in children with spinal deformities	15 children were divided into two groups including practice (n = 8) and control (n =7). Age 10-14	a 6-month treatment consisting of 30 sessions of kinesitherapy, massage and swimming exercises.	The scoliosis was corrected in 77% of children from the first experimental group and 55% from the second group.
Aliakbar et al., 2017	The effect of swimming exercise on the correction of thoracic kyphosis in patients with muscle dystrophy	11 children were divided into two groups including practice (n = 6) and control (n =5).	8 weeks, 3x1h/week	After eight weeks of specific reforms training, thoracic kyphosis angle decreased significantly in the experimental group. $p<0.001$
Shi Z, Zhou H, Lu L, et al., 2018	Aquatic exercises in the treatment of low back pain	A total of 331, 38.1% (n = 126) of patients were men and 61.9% (n = 205) were women.	8 articles, water exercises	The analysis result revealed that aquatic exercise could statistically reduce pain and increase physical function in patients with LBP ($p<0.05$)
Aksamit et al., 2019	The impact of a 60-minute swimming training on the quality of body posture and the level of balance in young adults	12 subjects, age 20-22,	60 min of swimming	There was a significant increase in pelvic rotation ($p = 0.02$).
Maniu et al., 2021	Does swimming exercises improve posture for blind and visually impaired children?	30 children, 14 boys and 16 girls, age 8-14.	practiced swimming, 2/ week, 60/session, 32 sessions	Swimming has positive effect in improving sagittal deviations of the spine for visually impaired and or blind children cervical $p<0.001$, dorsal $p<0.001$, lombar $p<0.001$
Vizitiu et al., 2021	Dorsalgia rehabilitation in static disorders of the spine by therapeutic swimming in young adults	15 subjects, aged 18-22	5 months. 2x1h/week, therapeutic swimming	Swimming can optimize health, reduce back pain and improve patients' lung capacity. Where the tests show a $p<0.05$, the statistical link is significant

Author	Title	Participants	Intervention	Results
				(S, 95% confidence) and when the tests show a p< than 0.01, the statistical link is significant (S, 99% confidence).
Pocovi et al., 2022	Walking, Cycling, and Swimming for Nonspecific Low Back Pain: A Systematic Review with Meta-analysis	320 retired athletes with chronic LBP; age, 37.6 ± 5.4; 40.0% female	swimming plus physical therapy, 30 min of swimming, 5 times per week for 6 months	There was low-certainty evidence that swimming was more effective than minimal or no treatment in the short term
Kozinoga, et al., 2022	Regular School Sport versus Dedicated Physical Activities for Body Posture—A Prospective Controlled Study Assessing the Sagittal Plane in 7–10-Year-Old Children	167 children (control group), 233 received (intervention group), aged 7–10 years	CG- were involved in regular school sport, IG- both school sport and a dedicated physical activities program (swimming and dance), 10 months, 1h/week	In 7–10-year-old children, participation in dedicated physical activities tends to improve their body posture compared to regular school sport.

Discussions

Swimming is a sport where the influence of gravitational force on the spine is reduced to a minimum. The posture adopted during swimming does not accentuate the curves of the spine. Also, the increased curvature of the spine creates more resistance and negatively affects the movement of the body during swimming (Torlakovic et al. 2014).

Aldvin Torlakovic has come to the conclusion that the implementation of a combined program of therapeutic swimming and hydrokinetotherapy, carried out over a period of 16 weeks, with a frequency of 2 times a week and a duration of 60 minutes, significantly improved the muscle tone, an aspect that contributed to improving children's posture (Torlaković et al., 2013).

The same conclusion was reached by Ganciu (2015), in their research, they have used swimming and medical gymnastics as a treatment method. The research involved 40 students of the University of Bucharest. In the “experiment” group, the program with swimming exercises and medical gymnastics was

implemented, whereas the "control" group followed the traditional physical education lessons learned in college. Due to the influences it exerts on the body, swimming is considered one of the most important means of achieving the objectives of physical education and sport, but also of physical therapy (Ganciu, 2015).

Benedek, in the research conducted, says that the combined program of physical therapy and swimming can be considered an effective method of reducing pain in the chest area and in correcting the kyphotic attitude, as well as in raising awareness of the importance of adopting a correct daily posture and improving the quality of life (Benedek & Raţă, 2017).

Muscular dystrophy is one of the muscle diseases in which deformations of the spine occur due to muscle atrophy and neuromuscular disorders. In the study conducted by Derikvandi, it can be established that specific backstroke exercises have a positive effect in correcting kyphosis in patients with muscular dystrophy (Derikvandi & Goudarzi, 2017).

Also a swimming programme implemented over a period of 4 months, 2 sessions of 60 minutes per week has a positive effect, according to Maniu, in correcting spinal deviations in the sagittal plane in visually impaired children (Maniu et al., 2021).

Karaleic states the fact that, swimming is a cyclic and symmetrical sport where both parts of the body are expected to perform the same movement, at the same time or alternatively, depending on the swimming style, so due to this principle, practicing swimming regularly positively influences the body asymmetry (Karaleic, 2014).

In his study, Martens says that posture is also influenced by the swimming styles we practice. In consequence, he analyzed a group of 200 swimmers, divided into 4 groups. With the help of electromyography, he analyzed each pull, depending on the style of swimming practiced and came to the conclusion that the muscles that influence the posture the most are the ones used in the backstroke and butterfly (Martens et al., 2014).

Modern lifestyle and reduced locomotor activity are the main factors in the occurrence of abnormal posture and a variety of spinal deformities (Kozinoga et al., 2022). The purpose of the research carried out by Ruska Paskaleva was to monitor the effect of isometric training and swimming in children with spinal deficiencies. They used a 6-month program, consisting of physical therapy sessions, massage and swimming, carried out three times a week. The obtained results concluded that the implemented program has a significantly positive effect on posture, muscle tone and mobility. Also, scoliosis was corrected in 77% of the children in the first group and in 55% of the children in the second group (Paskaleva, 2017).

Over the last decades, there has been an increased awareness of the possible harmful effects of performance sports on the lumbar spine and it was discovered that can cause spinal pain. Folkvardsen analyzed whether the practice of performance swimming leads to the occurrence of spinal pain. 196 children participated in this study, of which 100 have been practicing performance swimming for at least 8 years, and 96 of the children have only been practicing physical education in schools for a maximum of 3 times a week. From the results obtained, the author concluded that both groups had similar values, so it could not be established that performance swimming negatively influences the spine (Folkvardsen et al., 2016).

On the other hand, Zaina confirms that swimming is associated with an increased risk of trunk asymmetry and hyperkyphosis. Furthermore, although swimming has been considered a beneficial sport for treating scoliosis, the data presented by Zaina contradicts this aspect. A total of 329 teenagers participated in this study. These subjects trained at least 4 (up to 6) times per week with an average of 2-2.5 hours per training session. After analysing the results, the author concluded that swimming can increase the risk of kyphosis, lordosis, body asymmetry and can negatively influence lumbar pain in girls (Zaina et al., 2015).

However, the effects that the aquatic environment has on the gravitational force and the benefits that immersion in water has on the joint system are known. But there are not enough studies to confirm that practicing swimming, without selecting certain specific exercises according to the particularities of the deficiencies, has a positive effect on posture. Aksamit concluded that exercises improving the breaststroke did not affect the depth of thoracic kyphosis and lumbar lordosis. After 60 minutes spent in a relaxed sitting position, deepening thoracic kyphosis was observed. It is also not recommended that swimming replace medical gymnastics, but rather be an additional treatment in the correction of spine deficiencies (Aksamit et al., 2019).

In the "Aquatic exercises in the treatment of low back pain" study, Zhongju Shi tells us about the benefits that aquatic exercises have on back pain, especially in the lumbar area. The aim of this study was to systematically review all the evidence available in the specialty literature on the effectiveness of aquatic exercise. Through the PubMed, Cochrane Library, Embase and Allied Health database, according to PRISMA procedures, 8 studies were presented, involving 331 patients. In consequence, it was concluded that exercises in the aquatic environment significantly reduce pain in the lumbar spine and improve physical condition (Shi et al., 2018).

Thus, in the study conducted by Vizitiu in 2021, the researcher aims to discover the most effective methods of therapeutic swimming, in order to reduce the pain of the spine, 15 subjects participated in this experiment. They participated in one-hour treatment sessions twice per week, for a period of 4 months. The subjects were diagnosed at a physical therapy clinic in Suceava. After the statistical analysis of the data, we can see a significant improvement in spinal pain, therefore the adaptation and dosage of specific swimming exercises positively influences back pain (Vizitiu et al., 2021).

Also Pocovi, reached the same conclusion, investigating the effect of swimming, compared to the lack of a treatment, on acute back pain. From the analysis of the results, it appears that in the medium and short term, swimming insignificantly improves acute back pain (Pocovi et al., 2022).

In his paper, Stoychevski set out to discover the opinion of specialists in the field regarding the therapeutic effect that swimming has on children with postural deficiencies. For that reason, he used a questionnaire which he applied to 32 swimming coaches from Bulgaria. After analyzing the results, it was found that 70% of the coaches have children with posture problems or spinal deformities in their groups. More than 65% of the coaches say that the number of children with spine problems in their groups is up to 5 children, and 30.8% - up to 10 children. Most of the surveyed experts had children with spinal deformities in their groups and actively worked with them. That being the case, swimming coaches played a key role in preventing and correcting children's posture, as well as in training their motor skills and improving their physical condition. At the same time, they are of the opinion that the systematic practice of swimming positively influences posture deficiencies (Stoychevski, 2021).

Conclusions

The need for in-depth analysis of the effects of swimming on posture and spinal impairments persists. The analysis of specialized literature demonstrates that there are divided opinions on this subject. On the one hand, many specialists present the positive effects of this sport, due to the particularities of the aquatic environment. On the other hand, more and more studies appear to contradict this statement. Instead, most specialists recommended that swimming be accompanied by physical therapy, therapeutic massage or hydrokinetotherapy in the treatment of postural deficiencies in order to have the desired results. Furthermore, swimming coaches must have specific training in this regard and constantly communicate with the physiotherapist.

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