THE SIGNIFICANCE OF SWIMMING AND CORRECTIVE EXERCISES IN WATER IN TREATMENT OF POSTURAL DEFICITS AND SCOLIOSIS

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Abstract. More and more often specialized literature mentions the contemporarily relevant notion of the application of swimming as one of the therapeutic methods in modern medicine. The thesis reviews specialized literature and analyzes documents in order to demonstrate the significance of aquatic therapy and corrective swimming exercises as a corrective and therapeutic function in the treatment of postural deficits and scoliosis. As this article has a character of a review, its purpose is to attempt a concise synthesis of the knowledge concerning the impact of swimming as a sport on the development of the physiological spinal curvature, as well as to emphasize the significance of aquatic therapy and corrective swimming exercises in counterbalancing gravity and supporting the body weight and to demonstrate their health benefits.

Key words: aquatic therapy, swimming exercises, health benefits, corrective and therapeutic function, postural deficits, scoliosis

Introduction

Physical activity in the aquatic environment appears to be one of the most effective pro-health objectives. The significant potentiality to improve the posture results from the impact that the aquatic environment has on the human body at rest and during exercise. Among the substantial number of children and youth affected by various conditions, a vast percentage constitutes postural deficits and coronal spinal abnormalities, most frequently idiopathic. In view of the fact that swimming and water exercise may be instrumental in the development of the correct posture, the article reviews specialized literature in order to demonstrate the importance of aquatic therapy and corrective swimming exercises. As this article has a has a review character, its purpose is to attempt a concise synthesis of the knowledge concerning the impact of swimming as a sport on the development of the physiological spinal curvature, as well as to emphasize the significance of aquatic therapy and corrective swimming exercises in counterbalancing gravity and supporting the body weight and to demonstrate their health benefits. The article

was written on the basis of an analysis of documents and a review of research reports concerning the aspects of application of aquatic therapy and swimming exercises as a therapeutic function in postural deficits and scoliosis. The thesis was prepared in compliance with the ethical principles formulated by Kruk (2013).

Types of physical activity in the aquatic environment

Taking into account the purpose of physical activity in the aquatic environment, Iwanowski (1997) proposed the following classification of swimming:

- competitive swimming,
- recreational swimming,
- utility swimming,
- aquatic therapy – hydrokinsiotherapy.

Aquatic therapy may be divided into the following categories: competitive swimming for athletes with disabilities, hydrokinsiotherapy exercises, pro-health swimming, and swim therapy (Kołodziej 1989). Each of the above categories of swimming fulfils different functions that satisfy individual needs.

The importance of counterbalancing gravity and supporting the body weight in the aquatic environment

Swimming is one of the few forms of physical activity in sports and physical therapy that facilitates a harmonious and holistic development of the body with a minimum risk of injury (Radzimińska et al. 2013). On the basis of a questionnaire with 5,000 respondents between the ages of 16 and 65, Nicholl et al. (1991) concluded that recreational swimming is characterized by an inconsequential risk of injury. Also the research carried out in Belgium by Cumps et al. (2008) proves that swimming has the lowest incidence of injury among the 14 analysed most popular sport disciplines. The aquatic environment, due to its physical and chemical properties, creates very specific conditions for the human body, which are utilized in prophylaxis, therapy, and treatment (Iwanowski 1997). The interaction of the hydrostatic pressure of water and the buoyancy force reduces to the minimum the static work required in order to support the body, reduces the weight of joints and spine as well as muscle tone of the entire muscular corset (Kołodziej 1989). By counterbalancing gravity and supporting the body weight, the aquatic environment causes muscles to relax, which makes it easier to assume the correct posture (Barczyk et al. 2005). This reduces spasticity, which in turn offers an opportunity to increase the range of motion without pain, which would be difficult to achieve in the gymnasium (Pasek et al. 2009; Radzimińska et al. 2013). Research conducted by Iwanowski and Jaszczanin (1994) demonstrated the impact of exercise in counterbalancing gravity and supporting the body weight on the physiological spinal curvature.

The most important benefits of the aquatic environment for therapeutic exercise include:

- elimination of the body mass load, which reduces the tension of postural muscles and increases the chances of self-improvement of the posture;
- causing an additional forced movement of respiratory muscles;
- increasing the chest movement amplitude;
- delaying fatigue (Kołodziej 1989).

Movement in the aquatic environment generates a number of health benefits that include: oxygenation and increased immunity, increased endurance, improved function of the circulatory and respiratory system (Pasek et al. 2009). The beneficial impact of the aquatic environment on a rehabilitant was emphasized by Bulicz and Murawow

(2004), as well as Różański and Dorosz (2002). The positive outcome of therapeutic swimming (exercises with reduced body weight) in the case of poliomyelitis (Heine-Medin disease), dystonic scoliosis, abnormal function of the respiratory and the circulatory system, as well as in traumatic cases (Iwanowski 1997). Furthermore, swimming, as no other sport discipline, simultaneously activates the greatest number of muscles, and in particular spinal and abdominal muscles, which results in reinforcement of the entire muscular corset. The aquatic environment is one of the few places in which a patient who suffered an injury of the spinal cord may move without the aid of any orthopaedic equipment (Radzimińska 2013). The research completed by Naal et al. (2007) confirmed the effectiveness of aquatic exercises in the post-surgical rehabilitation. The aquatic environment is also beneficial for Turner syndrome patients, by alleviating typical complaints (Nonn-Wasztan et al. 2011). Numerous research reports confirm the beneficial influence of competences, problematic behaviour, and body awareness of children suffering from cerebral palsy (Ozer et al. 2007). The Halliwick Concept is increasingly used in therapy of children suffering from cerebral palsy, spina bifida, Down syndrome, mental disability, and spinal cord injury as a form of mobilization in the aquatic environment (Weber-Nowakowska et al. 2011).

The impact of competitive swimming on development of the physiological spinal curvature

Research into the impact of competitive swimming on development of the physiological spinal curvature was conducted by Iwanowski (1997). The research material constituted of 85 female athletes who had been practicing competitive swimming for over three years and were sport classes students. The control group consisted of young females who did not practice any sport. The obtained results demonstrated differences in the gamma angle corresponding to the lumbar spine in all styles of competitive swimming. In the beta angle, corresponding to the lower section of the thoracic spine, highly significant statistic differences were reported only for backstroke. Backstroke alleviates the extent of thoracic kyphosis, while breaststroke significantly increases the kyphosis arch. All the remaining styles do not have a significant impact on the beta angle. The author concluded that competitive swimming influences changes of physiological spinal curvature and may be useful in correction of postural deficits. Similar research was conducted by one of the authors of this thesis and was concerned with the impact of intensified physical activity in the aquatic environment on development of the physiological spinal curvature on the example of swimming training (Dolata-Łubkowska and Kruk 1996). Research demonstrated a changed physiological spinal curvature in children who practice swimming as against their peers who do not. This was particularly discernible in girls, where typical difference consisted in reduction of the angle of the lower section of the thoracic spine and reduced lordosis as against their peers who did not practice swimming. The changes observed in the conditions of counterbalancing gravity and supporting the body weight lead to the conclusion that swimming ensures the correct development of the physiological spinal curvature and may be useful in correcting postural deficits, particularly in case of excessive lumbar lordosis.

Fajdasz and Zatoń (2000), on the other hand, claim that swimming may have a negative impact on development of the physiological spinal curvature. They point to the predominance of kyphosis in the posture of swimmers. At the same time, they emphasize the positive impact of swimming on the frontal plane. This is not confirmed by research conducted by Łubkowska and Tarnowski (2012), who studied 212 children between the ages of 8 to 12 practicing competitive swimming and 330 peer who did not practice swimming. Results obtained by the researchers led to a conclusion that the strain of training (swimming training) in the early year of education (between the ages of 8 to 12) is not intensive enough to negatively impact the development of the physiological spinal curvature.

Research conducted by Maćkowiak and Wiernicka (2010) also did not confirm any negative impact of swimmers training on the development of the physiological spinal curvature. The authors studied 67 female synchronized swimmers between the ages of 13 and 18. The research demonstrated a smaller incidence of scoliosis and physical asymmetry in synchronized swimmers than in the control group, members of which did not practice any sport. This led to the conclusion that long-term synchronized swimming does not have a negative impact on the posture of female athletes, but rather it is beneficial for development of the physiological spinal curvature, just as in the case of swimming.

Research concerning determination of the impact of physical activity in the aquatic environment on correction of postural deficits in junior high school youth was conducted by Bielec (2011). The participants of the research were 114 students at the age of 13.5 who attended swimming classes as part of mandatory physical education program. The author of the research emphasized that the participating students did not perform any therapeutic exercises during their physical education classes. As a matter of fact, teachers were probably not even aware of the existence of any postural deficits in their students. Nevertheless, results obtained from the research enabled the author to conclude that scoliosis in students attending swimming classes was corrected more frequently than in their peers attending regular physical education classes.

Swim therapy and swimming exercise

The health benefits of the aquatic environment, especially in case of children and youth suffering from postural deficits, is now generally acknowledged and often highlighted. Polish scientific centres preoccupied with correction of postural deficits with the aid of water exercise include the centres in Silesia, Poznań, Cracow, Wrocław, Gdańsk, Warsaw, and Szczecin. According to the information published by the Ministry of Health, the majority of Polish provinces executes health programs financed by local governments, including prevention of postural deficits and their effects (Gołdynia 2010, pp. 176–177). Particularly interesting are programs that incorporate the corrective and therapeutic function of swimming:

- in Lubelskie Province, Przez pływanie do zdrowia (Getting healthy through swimming) educational and health program (Gołdynia 2010, p. 177),
- in Łódzkie Province, W zdrowym ciele zdrowy duch (In healthy body a healthy spirit) program, which includes swimming classes for children and youth (Gołdynia 2010, p. 178),
- in Wrocławskie Province, Trzymaj się prosto (Keep your back straight) program for promotion of health promotion and prevention of postural deficiencies in children and school youth to be implemented during years 2014–2015; the addressees of the program will be 3000 children and youth from Wrocław's kindergartens and schools of all levels of education (in every year of implementation of the program). One of the objectives of the program is to create in a health facility within the territory of the city of Wrocław at least 7 the so-called Postural Deficits Correction Centres; all facilities operated by each Centre have a corrective exercise room and an indoor pool; the program is expected, among others, to help maintain attendance at corrective exercise classes offered in a pool and in the gymnasium at the level of approximately 70% (2 hours a week) (Program promocji zdrowia... 2014, pp. 4–5),
- in Poznańskie Province, Poznań stawia na zdrowie – profilaktyka wad postawy wśród dzieci uczęszczających do klas I–IV szkół podstawowych w Poznaniu (Poznań supports health – prophylaxis of postural deficits in 1st–4th grade children of schools of elementary education in Poznań), which was

implemented by the Department of Health and Social Affairs of the Municipal Office of the City of Poznań between May 2009 and April 2011 (Kotwicki et al. 2011).

9,319 children were evaluated during the initial postural assessment. The fundamental component of the project was participation of children in preventative group corrective exercise, including corrective classes in the pool, which were referred to by project executors as pool classes (PC). Pool classes included a variety of corrective exercise methods as well as the fundamentals of swimming, Hallwick method, as well as water play and water games (Kotwicki et al. 2011, pp. 7–10). The results presented by Stoliński and Kotwicki (2011, 2012), concerning the final examination of the posture of 1000 children who participated in the project, demonstrated a reduction of the number of pathologies with the exception of scoliosis, which inexplicably increased in the final year.

The value and the benefits of aquatic therapy and corrective swimming exercises were appreciated by numerous advocates of correction of postural deficit in the aquatic environment such as Iwanowski (Iwanowski 1994, 1997), who developed asymmetric swim exercises applicable in cases of idiopathic scoliosis in kinesiotherapy. Iwanowski confirmed the effectiveness of this type of exercise on the basis of extensive observations during the years of his clinical practice (Iwanowski 1997). The importance of swimming and aquatic exercise in prophylaxis and treatment of postural deficits was also emphasized by Oprychał et al. (1993) and Tuzinek (2004). The therapeutic benefits of swim therapy and aquatic exercise was presented in the review published by Pasek et al. (2009).

Research concerning the impact of evaluation of the effectiveness of aquatic therapy for correction of postural deficits was conducted by Barczyk et al. (2005). The focus of the researchers' scrutiny were 106 children between the ages of 9 and 12 who were instructed to participate in aquatic therapy classes. The researchers were especially interested in analysis of thoracic kyphosis, lumbar lordosis, and the symmetry of the core in the frontal plane. Another group of researchers Barczyk et al. (2009) evaluated the impact of corrective exercise in the aquatic environment on forming of the anterior and posterior spinal curvature and the functional condition of the motor system in children affected by 1st degree scoliosis. A group of 94 children between the ages of 8 and 13 were examined during a 6-month program of swimming and corrective exercise in the aquatic environment. The authors demonstrated that corrective exercise in the aquatic environment influenced the angle of thoracic kyphosis, which was reduced, similarly to the angle of lumbar lordosis. At the same time, lower back muscles got reinforced. In another research, Barczyk-Pawelec et al. (2012) demonstrated that five months of corrective training resulted in a significant increase in chest flexibility, as well as in an increased chest circumference during inhalation. The developed aquatic exercise program resulted in a change in anterior and posterior spinal curvature in children with 1st degree scoliosis. The abovementioned changes consisted primarily in an increased length of the entire spine and actual thoracic kyphosis.

Research concerning the impact of corrective exercise in the aquatic environment on coronal spinal abnormalities was also conducted by Deskur and Zawadzki (2006). The authors examined 100 children between the ages of 6 to 12. The participating children were assigned to two groups: children participating in corrective exercise in water and those not participating. The research demonstrated an improvement of the inclination of individual sections of the spine in relation to physiological limits.

Aquatic exercise, apart from their corrective function achieved with the help of an environment characterized by a higher resistance, have a positive impact on improvement of strength and endurance. The above conclusion was presented by Sefańska and Zawadzka (2006) on the basis of measurement of strength of lower extremity extensors in children with 1st degree scoliosis participating and not participating in swim classes. The research was conducted

on a group of 52 children between the ages of 10–11. The research demonstrated that children participating in swim classes achieved significantly higher values of the maximum muscle moment arm, the average force, and the performed work, as achieved by the extensors of the knee joint. Similar research, conducted by Stefańska et al. (2008), concerned an analysis of strength and velocity parameters of core muscles in girls with 1st degree lateral idiopathic scoliosis, which were reinforced by two methods. The first method consisted of kinesiotherapy exercise in a gym at a rehabilitation centre, and the other method – an outpatient corrective process in the form of aquatic exercise in an indoor pool. As it was observed by the researchers, children who participated in swim classes had a better ratio of the force of spinal flexors and extensors. On the basis of this experiment the authors postulate that traditional reinforcement methods should be enriched with exercise conducted in the aquatic environment, which, according to them, will magnify the effectiveness of corrective exercise.

Research conducted by Rożek and Zawadzkiej (2005) demonstrated the effectiveness of a 5-month cycle of corrective exercise in water as regards selected functional parameters of the respiratory system in children suffering from scoliosis. The study included 89 children with 1st degree lateral scoliosis between the ages of 9 and 12. As it was noticed, the exercise program resulted in a significant increase of the vital lung capacity and the maximum voluntary ventilation.

However, as reported by an Italian researcher Marugo (2007), swimming is not unequivocally a positive tool for correction of postural deficits. According to the author, over exhaustion of some muscle groups during swimming may result in shoulder pain and in development of hyperkyphosis of the spine. It is hard not to agree with the author that only correct swimming techniques are beneficial as regards correction of postural deficits, which was emphasized on numerous occasions by Iwanowski (1997) in his reports, while Karpiński and Karpińska (2009) highlighted the fact that one of the key components of corrective exercise is precision with which they are performed. Guidi (1999), another Italian researcher, made similar statements, maintaining that all swimming exercises are beneficial as far as correction of postural deficits is concerned. Selection of individual aquatic exercises is essential in order to correctly execute the corrective function of physical education classes conducted in the pool (Bielec 2011). One should also take into account the contraindications to participation in aquatic exercise discussed in detail by Owczarek (1999) and Pasek et al. (2009).

Swimming has particular utilitarian and health benefits (Iwanowski 1997) and constitutes a form of physical activity that is conducive to preventative care, treatment, and rehabilitation offered as part of a holistic approach to a human being (Juszkiewicz and Swałtek-Juszkiewicz 2005). Swimming appears to be underutilized as a supportive tool in treatment of scoliosis, an ailment that has not been fully recognized. FITS concept deserves recognition in preventative treatment of scoliosis (Białek 2011), however the aquatic environment may be used for many types of swimming movements and numerous combinations of exercise movements (Iwanowski 1997). Works presented by Barczyk et al. (2009); Barczyk-Pawelec (2012); Deskur and Zawadzki (2006); Iwanowski (1997); Łubkowska and Troszczyński (2011); Rożek and Zawadzka (2005) and Stefańska (2008) confirm the soundness of application of hydrokinesiotherapy in the treatment of scoliosis. It seems that the most beneficial swimming stroke for correction of scoliosis is the breaststroke and asymmetric exercises based on application of the Rubcova's sequence (Iwanowski 1997; Łubkowska and Troszczyński 2011).

Research conducted by Łubkowska et al. (2000) concerning the scope of the shape of the anterior and posteriori spinal curvature of children demonstrated that they may be a symptomatic component in detection of scoliosis. Łubkowska (2012), on the basis of a study involving 1223 children, formulated the normative scopes of the

physiological spinal curvature, which are one of the first attempts to determine their angular values for the population of children and youth in Szczecin. According to Wilk (2013), they enable an approximate assessment of the posture. Planning physical therapy for children with idiopathic scoliosis (IS) requires incorporation of a systematic evaluation of spine mobility. Łubkowska et al. (2002) stated that the correct approach is to diagnose symptoms of asymmetry and to strive to eliminate them. Czaprowski et al. (2011) demonstrated that increased mobility of the spine (JHM) occurs more frequently in children with idiopathic scoliosis (51.4%) than in healthy children (19%). A diagnosis of JHM is not time consuming and is based on trials that are easy to perform. They may be performed with the aid of the Bunnell scoliometer (Kotwicki 2008, 2011), which would be a valuable asset in every school of primary education that would support implementation of health policy (Stoliński and Kotwicki 2011). This knowledge is very significant, as this is typical of children suffering from JHM, who are particularly prone to soft tissue injuries, which can occur as a result of engaging in physical exercise. Furthermore, reoccurring micro injuries may result in a higher risk of joint injury. Therefore, it is important to remember that some physical therapy methods and techniques that increase joint mobility may be contraindicated (Czaprowski et al. 2011). Children suffering from idiopathic scoliosis may recourse to an alternative form of treatment offered by swim therapy and corrective swimming exercise, which are successful thanks to the properties of the aquatic environment counterbalancing gravity and supporting the body weight.

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