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EFFECTS OF SENSOMOTOR COMMUNICATION SYSTEM BASED EXERCISES ON STATIC BALANCE AND SELF-ESTEEM IN 7–12 YEARS OLD KARATE PUPILS

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Abstract Karate is a martial art that require a high level of motor and functional abilities, discipline and mental concentration as well. Practicing Kata improves self-awareness and focus, but is not always included in a class agenda. The author's of sensomotor communication system based exercises have combined principles of movement from martial arts for body awareness. The purpose of this study was to examine the effects of 12 weeks intervention program of sensomotor communication system based exercises on static balance and self-esteem in karate pupils.
In the study 24 karate pupils in the age of 7–12 were included. Training years in karate varied from 1 to 4 years of practice. To assess static balance the Flamingo balance test was used, to evaluate self-esteem, a modified Rosenger self-esteem scale was used. The findings of this study showed a positive effect on static balance and a minor positive effect on self-esteem in karate pupils after the intervention. Sensomotor communication system based exercises could be used for balance and self-esteem improvement. Also, being a more understandable and clearer exercise system, the sensomotor communication exercise program could be a Kata alternative for younger children practicing karate.

Key words: balance, self-esteem, karate, sensomotor communication system

Introduction

Karate for children in Western societies

Martial arts are body, mind, and spiritual practices that have their traditions and philosophy with a common goal to defend oneself from a threat (Bu et al., 2010). Karate is a Japanese martial art that involves repeated sequences of strikes and defenses, that require a high level of motor and functional abilities such as muscle strength, agility, speed, flexibility, balance, and movement coordination (Zago et al., 2015). Karate requires discipline and mental concentration as well (Zetaruk, 2000). It is important to mention that karate consists of Kihon (basic skills), Kumite (sparring), and Kata (forms – sequence of movements without opponent) (Molinaro, 2020).

Studies report martial arts besides improving physical abilities have a positive effect on the mental health of children and adults: increases well-being, reduces aggression, and positively affect self-control and self-esteem (Greco et al., 2019; Harwood et al., 2017; Moore et al., 2018).

Bu et al. (2010) argue that nowadays martial arts evolve into the fitness industry, losing its deep sense of spirituality. Practitioners of martial arts traditionally practice meditation as a part of self-improvement, however, in western societies martial arts students focus exclusively on physical exercise, losing the context of these arts, and focusing on the competition while traditional practitioners view competition as a major distraction. As a result self-defense instead of self-improvement is emphasized. Although Harwood et al. (2017) argue that eastern combat arts were adapted for western societies retaining eastern philosophy, which aims to achieve such a state of mind when the participant is capable of fighting without aggressive feelings. This is carried out through Kata, respect for the teacher, self-restraint, and meditation (Harwood et al., 2017).

Kata refers to a detailed choreographed pattern of movements. It is practiced to memorize and perfect movements, to improve focus and discipline. In a basic class agenda for beginners, ¼ of the time is devoted to Kata. Kata is challenging for children, especially beginners because they easily get bored (Kleiman, 2012). However, it is worth mentioning that children practicing karate, both Kumite and Kata, have higher speed, strength, better coordination, and better cognitive function (working memory and attention) compared to their sedentary peers (Alesi et al., 2014).

Balance importance in karate

Acquiring stability and balance involves multiple physiological systems including the neuromuscular and sensory systems. At a cortical level, it is essential to integrate a number of afferent signals to maintain balance. Therefore balance, both static and dynamic, is often assessed to determine the status of neuromusculoskeletal control. Moreover, balance is often assessed as part of general motor development in standardized tests for children where balance is considered as a composite of overall motor coordination (Condon & Cremin, 2013).

In martial arts static and dynamic balance is a key performance determinant, especially in elite-level athletes. Karate provides a powerful stimulus to the neurological development of balance control, improves proprioception, and corrects body alignment. Karate training includes a lot of complex motor tasks that challenge balance and coordination – body rotation, bodyweight shifting, and single-leg stances (Zago et al., 2015). Also, while Kumite focuses more on dynamic balance, Kata focuses both on dynamic and static balance (Hadad et al., 2020).

Self-esteem & body awareness among children practicing karate

Positive self-esteem in children is a key element in developing a healthy personality (Haney & Durlak, 1998). Physical appearance and achievement are one of the self-esteem domains (León et al., 2021). By Drummond (2012) physical competence in a critical domain of self-esteem and physical abilities ensures that children are more accepted which is especially true for boys for whom physical fitness is more important because it enables them to demonstrate masculinity.

It is proven that martial art practitioners have higher self-esteem and self-control (Fabio & Towey, 2018). Martial arts also improve resilience in children (Moore et al., 2021). One of the techniques that is aimed specifically to improve self-control and self-awareness is Kata, because it provides inhibitory control and demands mindfulness (Lima et al., 2017). Hence body awareness has a positive correlation with performance emotional state in athletes (Erden & Emirzeoglu, 2018).

Most studies on body awareness are focused primarily on adults and people with acute or chronic medical conditions, but it is worth mentioning that body awareness based interventions have positive effects on movement quality, static and dynamic balance, and self-perception (Olsen et al., 2020; Bravo et al., 2019). Body awareness focused exercises improve postural control by enhancing proprioreception (especially in the knee and ankle joints), reorganizing muscular tension, improving muscle recruitment and co-contraction (Yagci et al., 2018; Xing et al., 2023; Fogaça et al., 2021).

Sensomotor Communication System

Sensomotor Communication System (MoComm) is a program in which authors – Tarass Ivaščenko (psychotherapist MD, PhD) and Sergejs Žukovs (karate coach) have synthesized the principles of movement and interaction from different disciplines of martial arts (Capoeira, Aikido, Wushu) gymnastics, and other systems (Tai Chi, Feldenkrais method) for physical body development and body awareness. The objectives of MoComm are to focus on body sensations and improve body awareness, reduce stress, and restore body and mind connection. Every MoComm exercise is smooth and within a normal physiological range of motion and it can be adapted to different populations (e.g. children, elderly, and people with chronic conditions) or used as an additional training method. It is the first research conducted on MoComm system and international papers on this topic has not been published yet. The Latvian Patent Office issued a certificate in 2021 Nr. 15632 for the rod, used in MoComm exercises.

By definition, sensomotor (or sensorimotor) means pertaining to, or concerned with both the sensory and the motor impulses of an organism (Merriam-Webster, 2022). Therefore sensomotor in this case refers to both the sensory and the motor impulses and is associated with body movement. Communication is an exchange of information and in MoComm communication is provided through movement and attention to perceived sensory information. The main principle of MoComm is paying attention to body movement and breathing, thus improving body awareness. There are no strict rules on exercise range of motion, pace, sets, and reps, on the contrary, a person is encouraged to choose these features him/herself according to well-being and body sensations. Unlike karate, there are no destructive, violent, or confrontational elements in MoComm. As a result, an individual focuses on self-exploration and self-experience safely, receiving positive body experience by gaining the freedom and choice to regulate features of given exercises. Moreover, focusing on perceived sensations from the body and its conscious integration improves communication between body and mind (Probst et al., 1997). The ability to be aware of own actions and perceived body sensations as well as being present, which is typical for mindfulness techniques, has proven to reduce stress-related symptoms and activate brain regions involved in emotional regulation (Boscarino, 2004). Paying attention to body sensations helps to recognize emotional changes and therefore increases control over them (Pavirzi & Damasio, 2001).

Aim

The purpose of this study was to examine the effects of 12 weeks of MoComm intervention on static balance and self-esteem in karate pupils. It was hypothesized that MoComm intervention program have positive effects on self-esteem and static balance in karate pupils.

Methods

Permission to conduct the study was granted by the Medical research ethics committee of the Latvian University.

Study design

The study was a 12-week intervention that has been evaluated using a randomized controlled study. Data were collected and recorded at baseline (pre-test) and after 12 weeks (post-test). After the pre-test and randomization, the experimental group received an intervention program. The control group received the same intervention program after the post-intervention assessment.

Participants and setting

The study site was a karate school located in Salaspils, Latvia. Participants were recruited by distributing information and consent forms to parents and children. Parents received a complete explanation in advance about the purpose of the experiment and parents provided written consent to the study. The procedures followed were in accordance with the ethical standards of the responsible institutional committee on human experimentation and with the Declaration of Helsinki. The study was conducted from July to September 2022.

In the study children in the age of 7–12 who were attending karate training regularly were included,, those with normal body mass index, with no acute injuries, and no chronic conditions. Initially, 26 children were recruited, but two of them dropped out. A total of 24 children aged 7–12 took part in the study. All of them were karate school pupils, attending 5 karate training per week: 13 children in the test group (TG) and 11 in the control group (CG). Training years in karate varied from 1 to 4 years of practice. During the intervention, every group continued with 5 karate trainings per week. TG additionally had two intervention sessions per week. After the second assessment, CG group had the same intervention on the same terms to reduce risk of possible feeling of inequality among children.

Measures

To evaluate static balance Flamingo balance test was used (FBT). In the FBT the subject stood upright on his or her fully stretched leg on a special wooden beam (50 cm long, 4 cm high, 3 cm wide), flexed the free leg at the knee, and gripped the foot with the hand on the same side. The timekeeper starts the watch and stops it each time the person loses balance, then starts over until the person loses balance again. The total number of losses of balance in one minute is recorded. The test is terminated if there are more than 15 losses of balance in the first 30 seconds. Participants performed FBT on both feet with a two-minute pause in between tests (Sember et al., 2020).

To evaluate self-esteem (SE) modified Rosenger self-esteem scale (CRSES) was used. Rosenberg self-esteem scale is widely used to assess self-esteem in adolescents and adults, modified version was adapted for use for schoolchildren aged 7–12 (Wood et al., 2021). It includes 10 items – five positive and five negative statements just like the original Rosenger self-esteem scale, but with altered terminology and simplified language, for example, instead of “I feel like I am a person of worth, at least on an equal plane with others” modified scale includes “I feel that I’m as good as everyone else”. Also, response options are altered to “very true”, “true”, “not true”, and “definitely not true”. Each response scored from one to four and the scoring is reversed for negative statements, so the higher score indicates higher overall self-esteem. CRSES scores range from 10 to 40. The results of the confirmatory factor analysis revealed that the CRSES provided an adequate fit for the global SE factor; meeting

the criteria on all goodness of fit statistics and displaying respectable reliability (Wood et al., 2021). Participants were asked to complete the questionnaire independently and honestly, based on their feelings at that precise moment. Questionnaires were completed inside the karate school environment. Also, a well-being score was used to evaluate overall well-being using a 0-10 point numerical scale, anchored by verbal labels: 0 – worst imaginable and 10 – best imaginable (OECD, 2013). Overall well-being score was used in order to identify possible issues that may affect the course of the study and result interpretation.

Intervention program

The intervention lasted for 12 weeks, twice per week, 45 minutes each session outdoors on nature trails. Intervention included:

1. Warm-up exercises, including breathing, coordination, and balance exercises (5 min);
2. Walking with simultaneous performing of exercises using a special rod (35 min). A rod is similar to a Taji Bang stick (or Tai Chi ruler). During this part, participants were encouraged to synchronize walking pace with arm movements, thus uniting movement, breathing, and attention;
3. Cool-down exercises: stretching, breathing, coordination, and balance exercises (5 min).

Statistical analysis

Data were analyzed using SPSS 23.0 officially licensed software**.** Non-parametric tests were used because of the small sample. Spearman's correlation test was used for non-parametric data. Related-samples Wilcoxon Signed Rank test was used to test the null hypothesis. Results are considered statistically significant if $p < 0.05$.

Results

Sample description

24 karate pupils participated in this study – 5 (20.8%) girls and 19 (79.2%) boys aged 7–12 (mean age 9.62). 17 (70.8%) children had a history of injury due to karate. The mean age in TG was 9.92 (SD ±1.60), mean age in CG was 9.27 (SD ±1.67). In TG 10 children out of 13 (76.9%) and 7 children out of 11 (63.6%) in CG had a history of a karate-related injury. The sample was too small to measure differences within groups by sex, age, and previous injuries reliably, although it is worth to mention statistically significant differences between the groups were not revealed. There was high adherence to the intervention program with a 91% average attendance. The main reasons for skipping were competition and sick days.

Flamingo test

The mean number of mistakes in TG before the intervention was 13.38 for the left foot and 14.31 for the right foot. The mean number of mistakes in the CG was 14.55 for the left foot and 14.18 for the right foot. There were no significant differences between the groups before the intervention ($p = 0.92$ for the lef foot and $p=0.65$ for the right foot). There was a noticeable improvement in the FBT scores in TG: the number of mistakes dropped for both feet – mean number of mistakes for the left foot was 10.77 and for the right foot – 10.92. The median differences between pre-intervention and post-intervention test results for the left and for the right foot were statistically significant ($p = 0.003$ and $p < 0.001$ accordingly). In CG the mean number of mistakes didn't change significantly ($p = 0.65$ for the left foot and $p = 0.34$ for the right foot) (Table 1, Figure 1).

Table 1. Mean number of mistakes in Flamingo balance test

Variable	Test group				Control group			
	Pre-test		Post-test		Pre-test		Post-test	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Left foot	13.38	2.81	10.77	2.74	14.55	2.91	14.73	3.16
Right foot	14.31	3.06	10.92	2.69	14.18	3.12	13.91	2.84

SD – standard deviation

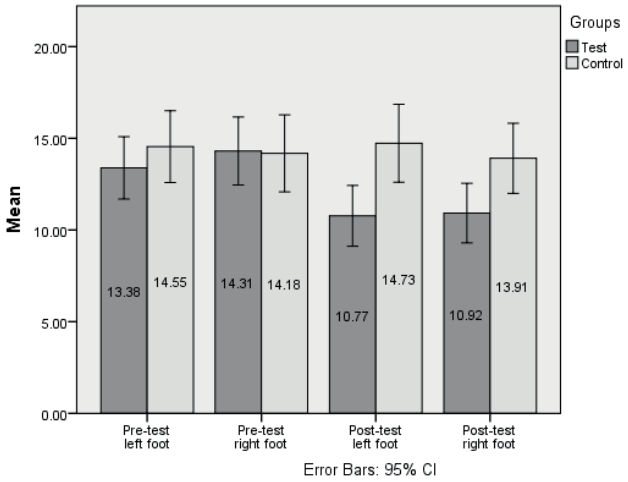

Figure 1. Mean number of mistakes in Flamingo balance test stratified by groups

Well-being and self-esteem

In TG mean well-being score was 7.77 before and 8.31 after the intervention. In CG mean pre-test score was slightly higher – 8.18 and the post-test score was almost the same as in TG – 8.36. There were no statistically significant changes in well-being scores before and after intervention ($p = 0.227$).

The mean SE score in TG before the intervention was 27.92 and un CG it was 27.27. There were no statistically meaningful differences between the two groups ($p = 0.51$). After retesting the results were 30.15 and 27.36 accordingly (Table 2, Figure 2). The median differences between self-esteem scores before and after intervention were statistically significant ($p = 0.019$). Also, there was a statistically significant difference in a specific CRSES item: "I'm happy with myself" with higher results among TG ($p = 0.020$).

Spearman's rho calculation for FBT for the left foot and SE scores differencies ($r_s = –0.36$ and $p = 0.08$) showed week and statistically insignificant correlation. Similar calculations for the right foot FBT result differencies and SE scores ($r_s = –0.47$ and $p = 0.0019$) showed moderate and statistically significant correlation.

Table 2. Self-esteem scores in both groups before and after the intervention

Variable	Test group				Control group			
	Mean	Max	Min	SD	Mean	Max	Min	SD
Pre-test	27.92	34	24	2.28	27.27	31	24	2.49
Post-test	30.15	35	23	3.48	27.36	32	24	2.06

SD – standard deviation

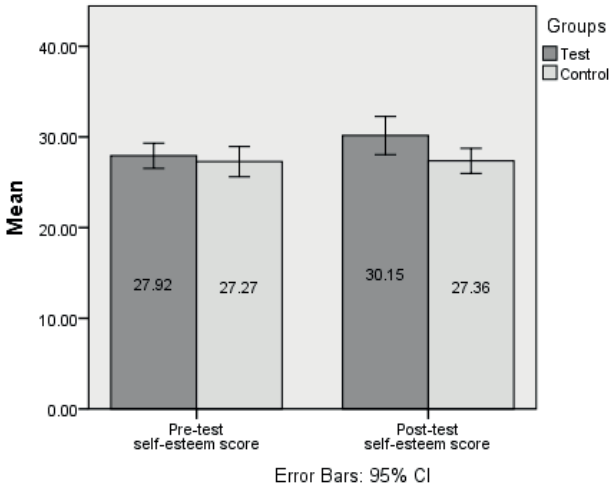

Figure 2. Mean self-esteem score before and after intervention stratified by groups

Discussion

The main purpose of this study was to determine if there are positive effects of MoComm intervention. The findings of this study show statistically significant improvements in FBT performance and in SE score.

To maintain a controlled upright posture, the central nervous system regulates sensory information and produces adequate motor output. Postural control deals with two tasks simultaneously – distribution of muscle activity and compensation for internal or external perturbations. The nature of movement and postural control is still being studied (Ivanenko & Gurfinkel, 2018). Body awareness can also be described as the sensitivity to bodily signals and being aware of bodily states and reactions to internal and environmental conditions. Body awareness-based interventions facilitate this mind-body connection by focusing on bodily sensations thus improving balance (Ginzburg et al., 2014).

Literature data show children develop body awareness primarily through motor experiences that require complex sensory stimuli perception and interpretation (Ahn, 2022). Hence, the positive effects of MoComm intervention on static balance might be explained by its features and emphasis on body awareness, paying attention and movement coordination. MoComm program has multiple advantages, that help to improve balance. Walking on uneven surfaces and manipulating the object simultaneously, requires coordination, attention, maintaining balance,

and a better understanding of own body signals to control it. Fabio & Towey (2018) stress that cognitive factors such as attention are essential to analyze, select and respond to stimuli, any interruption in one of these processes can have negative effects on sports performance. The more stimulus the athlete can pay attention to, the more the connections that he can create between them thus improving their performance.

However, it is challenging to compare FBT results with other statistical data due to differences in methodology, age of participants, small sample, and years of practice.

Moreover, for the study participants, the intervention program was the only training without competitive elements (thus removing both physical and emotional tension) and children could focus on themselves entirely. This might explain the improvement in self-esteem, because it was one of the activities children could enjoy freely, choosing their rhythm and speed, taking pauses as they please. Also, the intervention program didn't include comparison and ranking by achievement. Haney & Durlak (1998) claim it is possible to improve self-esteem by specifically focusing on it rather than trying to modify it indirectly (Haney & Durlak, 1998). Exploring oneself through movement could be one of the keys to improve self-esteem indirectly, without special psychological interventions.

There are studies that show the positive effects of Kata. For example, a 10-week karate intervention program included 5 min meditation and 10 min Kata for 11–13 years old healthy children proved to improve resilience among children (Moore et al., 2021). The motor strategies used to maintain balance depend on a number of sensory inputs – visual, vestibular, and somatosensory. It is important to mention that balance control development continues up to late periods during childhood (Assaiante, 1998). Kata improves dynamic and static stability (Ansari et al., 2021). Studies also show that Kata students have greater ankle stability compared to Kumite students (Molinaro, 2020).

However, as it was mentioned before, Kata is challenging for children and many Western schools do not include Kata in their usual karate training (Kleiman, 2012). Study participants didn't have Kata practice in their usual karate training routine. Even though evidence shows that any resistance training and bimanual coordination in karate require attention, work memory, and discipline (Lima et al., 2017), skipping Kata means missing opportunity to improve. There are lack of studies and opinions on what could substitute Kata for children, to gain the same positive effects but in a more understandable and acceptable way for children from western societies.

For example, there are Tai Chi routines developed for children. Tai Chi, for example, proved to enhance postural responses by improving neural mechanisms controlling ankle joints and reducing muscle co-activation, which reduces energy expenditure and thus makes balance responses faster (Gatts & Wolllacoot, 2006). Also, Kleiman (2012) suggests various games as a part of a warm down, including activities that involve balance training, that are more fun and increasing desire to participate.

Bu et al. (2010) pointed out that the most difficult point for researchers of martial arts is the investigation design and evaluation criteria of body-mind exercises, as they do not always match standards for medical studies. Also, there are no specific measurements to evaluate body-mind connection, especially among children. By measuring static balance we can make assumptions about children motor development and body controls, but by measuring self-esteem we can make assumptions about positive effects of a particular intervention program.

In addition, it is important to mention that despite the sample of this study being small, it showed a concerning tendency of the majority of young children to have a history of karate-related injuries. Generally, karate for children is considered safe in terms of injury risks. The risk of injury increases with each training year with most injuries occurring in tournament settings and free-sparring. Also, more than 3 hours of training per week increases the risks

of overuse injuries by repetitive microtrauma (Zetaruk, 2000). Most common injuries occur around age 12 to lower leg and wrists, strains or sprains mostly (Yard et al., 2007).

The main limitation of this study is it's rather a small sample that could affect the results. It is worth to mention that there are no specific tests that could be applied to measure body awareness in karate pupils, especially in children. Many of currently available observation and evaluation tools for body awareness are not applicable to children (Probst, 2018). Of course using modern methods for the equilibrium evaluation would increase the reliability of the results, but unfortunately authors were limited in resources. Also, years of practice were not taken into consideration, which too, has an effect on static balance and self-esteem.

Conclusions

Sensomotor communication system exercise program has a positive effect on static balance and minor positive effect on self-esteem in karate pupils after the 12-week intervention program. Therefore it could be used for various purposes – balance, body awareness and self-esteem improvement. Also, being a more understandable and clearer exercise system, the sensomotor communication system exercise program could be a Kata alternative for younger children practicing karate.

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