

# Using Martial Arts Training as Exercise Therapy Can Benefit All Ages

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<sup>1</sup>Rehabilitation Neuroscience Laboratory, University of Victoria, Victoria, BC, Canada; <sup>2</sup>Human Discovery Science, International Collaboration on Repair Discovery (ICORD), Vancouver, BC, Canada; <sup>3</sup>Department of Motor Behavior, University of Isfahan, Isfahan, Iran; and <sup>4</sup>Division of Medical Science, University of Victoria, Victoria, BC, Canada

SUN, Y., R. TABESHIAN, H. MUSTAFA, and E.P. ZEHR. Using martial arts training as exercise therapy can benefit all ages. *Exerc. Sport Sci. Rev.*, Vol. 52, No. 1, pp. 23–30, 2023. *Martial arts training focuses on whole-body movement patterning, philosophy, interpersonal interactions, and functional self-defense. Such training has positive impacts on physical, psychological, and cognitive well-being in older adults and children with and without clinical conditions. We hypothesize that martial arts training can be delivered as a form of exercise therapy for people at all ages to enhance overall health.* **Key Words:** martial arts, balance training, mental health, older adults, autism spectrum

## Key Points

- Balance training is embedded in the practices of martial arts such as Chinese kung fu and Okinawan and Japanese karate. Long-term training can enhance balance control in older adults.
- Repeated sequential movement practice during martial arts training reduces stereotypical behavior in children on the autism spectrum.
- Mindfulness and philosophical education in martial arts training also benefit psychological and cognitive function in people of all ages.
- Martial arts are holistic exercises that have positive impacts on both physical and mental health and are accessible to people at various fitness levels. It should be considered a therapeutic exercise for children on the autism spectrum and older adults to improve overall well-being.

## INTRODUCTION

Physical activity is important in preventing and managing chronic health conditions and enhancing recovery after neurological disorders. However, most adapted fitness programs require special equipment and are conducted in a clinical setting.

For community-dwelling older adults and people with chronic conditions, it is difficult for them to exercise regularly. For example, the adherence to prescribed exercise after discharge is less than ideal (*i.e.*, ~65%) among people with stroke (1) and older adults with impaired balance (2). Adolescents with developmental conditions, such as autism, are less likely to engage in physical activity (3,4) and more likely to be overweight and obese (3). Some top barriers for them to continue exercise include “exercise is boring,” “afraid of injury,” and “weather” (1,2,4). Therefore, it is important to include programs that are fun, easily accessible, and can be adapted to different fitness levels for community-based practice.

Martial arts are an ideal form of exercise that is accessible to people of all ages and fitness levels. In this article, the term “martial arts” refers especially to traditional East Asian martial arts including Chinese Kung Fu (*e.g.*, Tai Chi Chuan, Wing Chun), Korean martial arts (*e.g.*, Tae Kwon Do), Okinawan and Japanese Karate, Judo, and many others. Beyond their combat and self-defense purposes, which are commonly recognized in Western society, martial arts training often integrates mindful whole-body movements, breathing techniques, repetitive practice of balance and postural change, and philosophy into the training. In China and Japan, martial arts have been practiced for their health benefits by people of all ages for centuries. Earlier studies on the physiological response and adaptations to long-term martial arts training were mainly focused on healthy adults and professional athletes (5–11). Although it is important to understand the benefits of martial arts on physical fitness in young and healthy adults, examining how martial arts affect people with reduced physical capacity (*i.e.*, older adults and children with chronic conditions) will benefit a greater population. For a long time, the therapeutic effects of martial arts training were mainly recorded anecdotally and were sparsely documented in scientific literature. In the past decades, a

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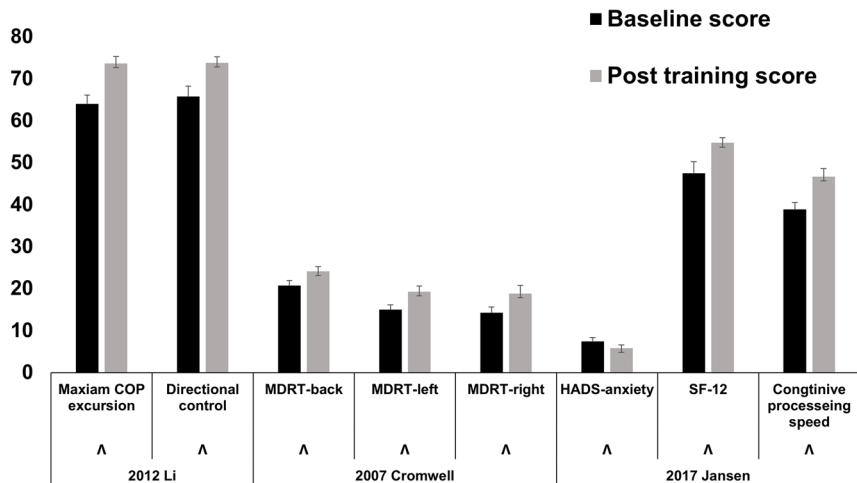
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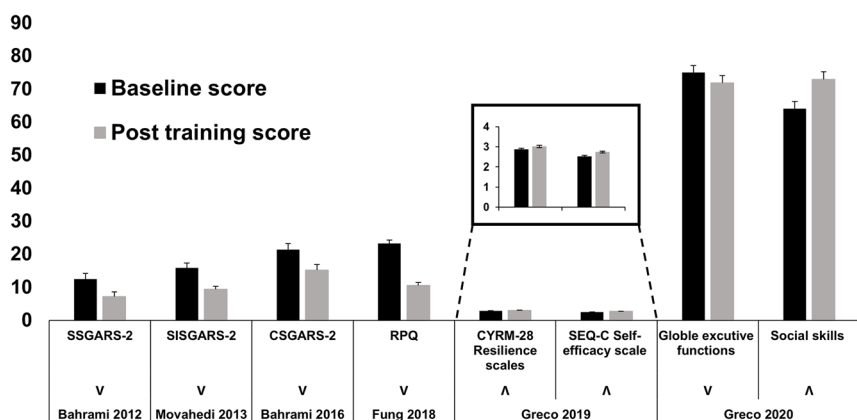


**Figure 1.** Enhanced balance performance, mental health, and cognitive function after martial arts training in older adults. Data are from studies that reported the mean and SD of each measurement. Labels underneath the x axis indicate the name of the measurements, the desired direction of change (represented by the arrows), the year, and the first author of the study. Standard error bars were calculated from the SD and number of participants reported in each study. All measurements showed significant differences between baseline and posttraining assessment. COP, center of pressure; HADS-Anxiety, Hospital Anxiety and Depression Scale, Anxiety subscale; MDRT, multidirectional reaching task; SF-12, 12-Item Short Form Survey.

growing number of studies confirmed the therapeutic effects of martial arts training on different aspects of health, such as improved balance control (12–14) and mental health (15) in older adults (Fig. 1), and reduced stereotypic behaviors in children on the autism spectrum (16,17) (Fig. 2). This review will delve into the key elements embedded in martial arts practice and the results from modern scientific assessments to reveal why martial arts can be used as exercise therapy and benefit people of all ages.

One unique feature of martial arts training and practice is mindfulness, which not only has many health benefits but also makes martial arts accessible for people at different fitness levels. Mindfulness focuses on how the movement is executed without immediately judging the results of it. For example, when practicing punches, practitioners focus on coordinating whole-body movement to optimize the power of a punch instead of how fast the fist moves. With beginners, training starts at a slow pace with an emphasis on proper posture alignments

and then gradually evolves into complicated movement patterns. This approach reduces the risk of injury while providing sufficient challenges to build up balance, agility, and coordination for people at different levels of fitness. For example, Tai Chi Chuan, often simply referred to as “Tai Chi,” characterized by its slow but continuous whole-body movement, has been used commonly for balance training in older adults and people with Parkinson’s disease. Its effectiveness in preventing falls has been confirmed in several literature reviews (14) and meta-analyses (18,19). Other types of martial arts, such as karate, Wing Chun, and Tae Kwon Do, may be misunderstood as “too dangerous” for older adults because it contains ballistic movements and vigorous fighting skills that may cause fall. In fact, those types of martial arts also involve mindfulness and combine both slow and fast movements in training. Emerging evidence confirms the effectiveness and feasibility of modified karate (12,20) and Tae Kwon Do (21,22) training in improving balance control in healthy middle-aged to older (>40 yr old) adults, as well



**Figure 2.** Martial arts training-induced changes in behaviors of children and adolescents. Data are from studies that reported the mean and SD of each measurement. The label of the x axis indicates the name of the measurements, the desired direction of change (represented by arrowheads), and the year, and the first author of each article. Standard error bars were calculated from the SD and number of participants reported in each study. All measurements showed significant differences between baseline and posttraining assessment. CSGARS-2, communication subscale of Gilliam Autism Rating Scale-Second edition; CYRM-28, Child and Youth Resilience Measure; RPQ, Reactive-Proactive Aggression Questionnaire; SEQ-C, Self-Efficacy Questionnaire for Children; SISGARS-2, social interaction subscale of Gilliam Autism Rating Scale-Second edition; SSGARS-2, stereotypy subscale of Gilliam Autism Rating Scale-Second edition.

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as older adults with neurological conditions, and children on the autism spectrum. Studies on middle-aged to older adults (55–85 yr old) also show that Wing Chun practice improves upper and lower limb muscular strength (23,24).

Developed as traditions of fighting skills, most martial arts movements have functional meaning in a combat situation, and training eventually involves practicing attack and defense skills with a partner. During practice, physical exercise, social interaction, and philosophical education are all carried within meaningful movements, which can benefit overall well-being. For example, during self-defense practice with a partner, balance control is trained through repeated turning and stepping with proper body alignment. Even though the fighting skills may not be applied in real life, the coordinated whole-body movement can be easily transferred to many daily situations, such as stepping away from perturbation while maintaining balance. Social interactions and mutual respect from group training play an important role in mental health and cognitive function. Reduced depression and anxiety, as well as improved cognitive function were observed in older adults (15,25), as well as children with (16,26) and without developmental conditions (27,28). These improvements were confirmed through not only behavioral assessments but also neurological assessments. Several studies indicate that martial arts training increased peripheral brain-derived neurotrophic factor (BDNF) (29,30) and oxytocin release (31), which are associated with neural plasticity and social behavior.

Different from common therapeutic approaches where intervention exercise is overtly aligned with the desired outcome, martial arts training carries the desired training attributes in a meaningful context, like using the physical attributes of superheroes to communicate physiology and neuroscience, where the key science points are embedded within a relevant context and are partially understood already to leverage the transfer of knowledge (32). Martial arts training includes a variety of physical, psychological, and philosophical stimuli through meaningful and functional movements (Fig. 3). In this review, we propose our novel hypothesis that martial arts can be delivered as

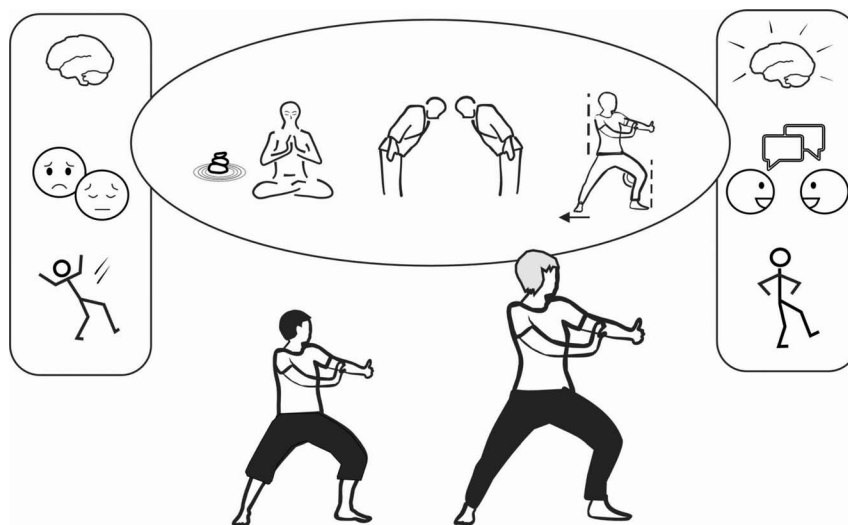
a form of exercise therapy that can be adapted to people with different fitness levels and benefits many aspects of health for people of all ages. We highlight findings focused on older adults and children with and without clinical conditions as these two age groups usually experience greater challenges in engaging in exercise activity compared with young healthy adults. Exercise that can be adapted to these two age groups has more potential to generalize a broader population. Because people of different ages face different challenges in their overall health, we focused on the changes in balance control, mental health, and cognitive function observed in older adults, and behavioral and social skills changes observed in children and adolescents. We recommend that martial arts training should be considered a therapeutic intervention that can be provided for people of all ages with different needs in their overall well-being.

## Martial Arts in Older Adults

*Martial arts training enhances balance control and prevents falls in older adults*

Falling is one of the leading causes of injury hospitalization in older adults (33). People with neurological disorders, such as stroke or Parkinson's disease, have even higher incidences of falls compared with age-matched control (34–36). Therefore, enhancing balance function and reducing the incidence of falls are associated with better quality of life for the elderly.

Balance training is embedded in many styles of martial arts practice. For example, both Tai Chi and karate involve sequential movement practice called “tao-lu” in Chinese or “kata” in Japanese. Developed to mimic different fighting scenes, kata and tao-lu practice emphasizes integrated postural control during stepping, turning, and transitioning between different stances. Although sequences of movements challenge balance control at different levels, the practice usually starts at a slow pace with few rigorous and ballistic movements. It is ideal for older adults to build up their balance control skills safely. Tai Chi is one of the most studied martial arts for balance training. Several



**Figure 3.** Martial arts train the body and mind at the same time, thus promoting both physical and mental health. During martial arts training, participants (represented by the child and the older adult in the figure) engage in physical exercise through mindful movement while simultaneously practicing etiquette behaviors and integrating martial arts philosophy (shown in the oval in the background). These training stimuli lead to improved cognitive function, communication skills, mental health, and balance control (changes are represented by the vertical panels in the background).

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meta-analyses indicate that practicing Tai Chi can effectively reduce the incidence of falls in older adults (18,19). Improved balance function, such as Berg Balance Test score, maximal center-of-pressure excursion during quiet standing, and gait variability during dual task, was observed in healthy older adults (37) and older adults with Parkinson's disease (14,38), cerebellar ataxia (39), and mild balance impairments (40) after 20 to 36 sessions of training. Improved balance control also was seen after karate training. Dahmen-Zimmer and Jansen (12) showed that 30 sessions of karate training significantly increased one-leg stand duration in participants with Parkinson's disease. A recent study by Mustafa *et al.* (20) showed that 15 sessions of karate kata training enhanced dynamic balance reactions in a group of older adults with or without neurological disorders.

Balance control is a complicated skill that involves multiple structures in the nervous and musculoskeletal systems; although it is hard to identify all underlying mechanisms that enhance balance control, improved sensorimotor function and leg muscle strength may be parts of the reason (41–45). When practicing movement sequences that involve bodyweight shifting and stepping, sensorimotor function and muscle strength are trained unintentionally. Many styles of martial arts emphasize proper body alignment during standing and stepping with knees slightly bent all the time. In a self-defense situation, these allow the person to step away from the attack quickly and be in a good position to counterattack. In daily training, the proprioceptive system and lower limb muscles are actively involved through repeated practicing and refining movement sequences. Improved sensorimotor function and muscle strength were observed along with enhanced balance control after different martial arts training (41–45). For example, long-term (1–3 yr) Tai Chi practitioners showed shorter reflex latency in the hamstring and gastrocnemius muscles after perturbation, smaller knee joint reposition errors, and longer balancing time on a tilted board compared with short-term (3 months) practitioners and control group (44). In an interventional study by Wu *et al.* (43), older adults attended Tai Chi practice three times per week for a minimum of 3 yr, and they showed smaller postural sway during quiet standing and greater maximal knee extensor strengths compared with the age-matched control group. This study also show a significant correlation between the center-of-pressure excursions and the eccentric strength of knee extensors in the Tai Chi group, suggesting that greater leg muscle strength is associated with better balance performance (43). Similar trends were observed in Wing Chun practitioners where long-term (>1 yr) practitioners have higher maximal knee extension and flexion torque (41), as well as better performance in Berg Balance Test, sit-to-stand test, and greater balance self-efficacy compared with aged-matched control (42,45).

In a recent systematic review that examined the effects of different exercises on preventing falls in community-dwelling older adults, exercises that target multiple components including standing balance, gait, and muscle strength were found to be more effective (46). Tai Chi, karate, and many other styles of martial arts indirectly train all these components. With proper training approaches that are customized to the condition of each participant, long-term martial arts can be a safe and effective balance exercise for older adults. More recent efforts that include specific programming for these outcomes have been published in a generally accessible format (47).

### *Martial arts training enhances mental health and cognitive functions in older adults*

Aging-related physiological changes, chronic conditions, and neurological disorders are the leading causes of mental health issues such as depression in older adults (48,49). The prevalence of major depression in adults older than 75 yr ranged from 4.6% to 9.3%, and the prevalence of subthreshold depressive symptoms ranged from 4.5% to 37.4% (50).

Along with improved physical health, martial arts are beneficial for the overall mental health and cognitive functions in adults with and without clinical conditions (51). Several studies indicate greater effects of martial arts training compared with practicing physical or mental exercise alone (15,25). Jansen and Dahmen-Zimmer (25) compared depression scores in older adults who received physical exercise training, cognitive training, and karate training with the control group. Only the karate group showed significantly reduced depression. In another study by the same group of researchers (15), the effects of karate training and mindfulness training on emotional well-being and cognitive function in older adults were compared. Participants who received karate training showed improved cognitive processing speed, subjective mental health, and reduced anxiety, whereas no significant change was observed in participants who received meditation-based training alone (15). The authors proposed several reasons for the greater beneficial effects of karate training compared with physical, mental, or cognitive training alone. For example, the combination of physical and cognitive training (*i.e.*, memorizing and performing the sequence of movements) in karate practice induces a “time out” from negative thoughts. Being able to complete a difficult motor task and imagining a fighting scene during the practice may boost self-esteem and enhance creative thinking (15,25).

In addition to the behavioral assessments, the beneficial effects of martial arts training on cognitive function were further confirmed through neurological assessments. Increased peripheral BDNF release was observed after Judo (29) and Tai Chi (30) training. BDNF plays a key role in memory formation, neurogenesis, and neural plasticity. The effects of physical exercise on peripheral BDNF have been mainly focused on aerobic and resistance training (46,47), but emerging evidence shows that martial arts training can induce similar effects in older adults. A study by Kujach and colleagues (29) indicates that 12 weeks of Judo training not only improved balance and muscle strength but also reduced execution time in the Stroop Test and increased peripheral BDNF in older adults. In a randomized controlled trial by Sungkarat *et al.* (30), older adults with mild cognitive impairment were randomized into a Tai Chi group that practiced Tai Chi for 6 months (50 min per session, three times a week) or an educational group that received reading material related to information related to cognitive impairment and fall prevention. At the end of the training, participants in the Tai Chi group showed significantly higher scores in memory and execution function tests, as well as higher plasma BDNF. These results suggest that martial arts practice induces similar effects on the nervous system compared with moderate to intense aerobic exercise or resistance training. This provides an alternative way for older adults, especially those who cannot do strenuous exercise, to gain equivalent benefits.

Enhanced cognitive function and mental health also may relate to the breathing techniques practiced in martial arts training.

Many styles of martial arts training emphasize slow breathing with inhaling through the nose and exhaling through the mouth. In advanced karate kata practice, breathing is coupled with stepping and arm movements. Although there is a lack of studies examining brain activity during martial arts practice, studies using brain imaging techniques revealed that breathing can regulate multiple sites in the nervous system. Breathing rhythm is coupled with oscillatory brain activity across the frequency spectrum and affects sensory processing (52,53). More specifically, activities in the piriform cortex, amygdala, and hippocampus were synchronized with the rhythm of nasal breathing but not oral breathing, which led to better fear discrimination and memory accuracy during the inspiration phase of nasal breath (54). The association between slow breathing and perceived relaxation, parasympathetic activity (shown as increased heart rate variability), and cortical activity (shown as increased alpha power and decreased theta power in brain activity) was confirmed in a systematic review (55). This evidence indicates that mindful breathing during martial arts training may play a role in improving cognitive function and reducing depression as observed in other studies (15,25), more neurological research on this topic is needed.

## Martial Arts in Children and Adolescents

### *Martial arts training reduces stereotypy behavior in children on the autism spectrum*

Autism spectrum disorder is a developmental condition that is characterized by stereotypic behaviors and deficits in communication and social interactions. The manifestation of autism varies among individuals, and some may experience difficulties in learning in a typical classroom, participating in physical activities, and interacting with peers.

Reduced stereotypic behavior has been observed in several studies after martial arts training such as karate (17), Tai Chi (56), and Judo (16). Although the underlying neurological mechanisms need to be further studied, repeating patterned movement sequences with proper sensory stimulation can be part of the reasons. Stereotypic behavior has been described as a learned and operant behavior that is maintained by its pleasant sensory consequence (57). It was proposed that movements and environments that induce similar sensory feedback may reduce stereotypic behavior (58,59). This theory is supported by Tse *et al.* (60) where children on the autism spectrum practiced ball tapping for 24 sessions over 12 weeks. After the intervention, hand flapping was significantly reduced, but no change was observed in body rocking. These results indicate that it is important to choose exercises that match stereotypic movements for the intervention (60). Many martial arts movements share similar biomechanical characteristics with stereotypic behavior. For example, karate training involves controlled rapid arm movement during punching and blocking (17), and judo practice involves holding, lifting, throwing, and falling techniques (16). The rapid arm motion and changes in body orientation may induce similar proprioceptive and vestibular inputs to those from hand flapping and body rocking. In addition to the self-generated sensory input, visual stimulation, verbal cues, and manual guidance also often are provided by the instructor during martial arts training. The ample sensory stimulation chil-

dren receive through training may reduce the need for performing stereotypic behavior in daily life (17).

### *Martial arts training enhances social skills and reduces aggressive behavior in children and adolescents*

In martial arts training, philosophy and etiquette behaviors are as important as physical skills. One of the key components of martial arts philosophy is respecting the instructors and peers. Etiquette behavior, such as bowing and expressing gratefulness for training with each other, is emphasized at the beginning and the end of each session and when practicing with a partner. Martial arts also emphasize self-improvement instead of comparing with others or using physical power to achieve dominance. When practicing self-defense skills with a partner, self-control also is practiced so the practitioners protect not only themselves but also the opponents from injury.

The inclusion of etiquette and philosophy education has many positive impacts on children and adolescents. After martial arts training, greater self-efficacy, socioemotional competence, communication skills, and reduced aggressive behavior were observed in both typically developed children (27,28) and children on the autism spectrum (16,26,61–63). The importance of including both philosophy and physical training was emphasized by a randomized controlled study by Fung and Lee (28). In their study, 298 children between grades 2 and 5 ( $8.52 \pm 1.08$  yr, mean  $\pm$  SD) with a high risk of aggressive behavior were divided into four groups to learn 1) martial arts skills and philosophy, 2) martial arts skills only, 3) martial arts philosophy only, and 4) physical exercise (control). After 10 sessions of training, children who learned both martial arts skills and philosophy showed significantly decreased aggressive behavior, delinquent behavior, anxiety/depression, and attention problems, and these changes were maintained 6 months after training (28).

Combined physical and philosophical education in martial arts training indirectly addresses some of the key components of executive function, which are associated with communication and social behavior (64). Executive function involves multidimensional functions including behavior inhibition, working memory, and cognitive flexibility (65). Martial arts train all these components through memorizing movement sequences, self-discipline, and interacting with peers and instructors respectfully. The association between enhanced executive function and social skills was confirmed in a randomized controlled trial where children on the autism spectrum (8–11 yr old) either received 12 weeks of karate training or were in a waitlist control group (26). Executive function and social skills were assessed by parents through the Behavior Rating Inventory of Executive Function and the Skills Improvement System Rating Scale, respectively. Enhanced executive function including emotional, cognitive, and behavioral regulation, along with improved social skills and reduced problem behavior, also was observed in children who received karate training (26).

Although the neurophysiological mechanisms that drive executive function and behavior changes remain further studied, a recent study on adult and adolescent Jiu-jitsu practitioners indicates that altered hormone release is one of the factors. In this study (31), saliva oxytocin was measured in Jiu-jitsu practitioners who are free from neurological condition (27.1  $\pm$  12.6 yr old) before and after sparring practice. Increased oxytocin release was

observed right after high-intensity sparring training in both novice and long-term practitioners. In addition, greater oxytocin release was seen after grappling compared with punch-and-kick sparring, indicating that sensory input during close-contact martial arts practice may have a greater impact on social behavior. Oxytocin is a neuropeptide that regulates social behavior, especially social bonding. Preliminary studies showed the potential of using intranasal oxytocin to enhance social and cognitive function in children with autism and schizophrenia (66–68). However, the optimal dose, delivery pathway, and its effects on a large population are still to be studied (67). The results from Rassovsky *et al.* (31) show the potential of using martial arts as a nonpharmacological approach to enhance social behavior in the neurodiverse population.

## ACCESSIBILITY AND ADHERENCE

The feasibility of implementing a community-based martial arts program for older adults and people with clinical conditions was noted in many studies with low dropout rates and high adherence. As cited earlier in this article, karate training can be safely adapted for older adults and people with Parkinson's disease. Two feasibility studies on people with Parkinson's disease showed that 15 of 19 participants completed a 10-weeks intervention (69) and 16 of 25 participants completed a 30-weeks intervention (12) with no adverse events reported. Lower dropout rates were observed in healthy older adults who received karate training (8%) compared with those who received meditation-based mindfulness training only (21.1%) (15).

Because martial arts practice often takes less place than many aerobic exercise and can be done without any equipment, people who cannot travel easily can practice at home or in a community setting. An increasing number of studies confirm that home-based Tai Chi training (70,71) or combining self-practice at home with instructed Wing Chun (23,72) and Tai Chi (73) training is well accepted and feasible among older adults. For people who cannot stand independently, seated Tai Chi has been implemented for people with subacute stroke (73) and older adults who use a wheelchair for mobilization (74). With a focus on upper limb movement, postural alignment, and breathing, seated Tai Chi increased joint ranges of motion and function in the upper limb (73) and improved the overall quality of life (74). A high compliance rate of 78.8% (73) and an attendance rate of 85.3% (74) were reported in those studies, respectively.

For children on the autism spectrum, participating in a community-based martial arts program and training with children without developmental conditions also is feasible. In a study by Greco and De Ronzi (26), three or more children without developmental conditions attended each training session to model appropriate behaviors in the class and initiate social interactions with children on the autism spectrum. Along with the improved executive function and communication skills we cited earlier, children on the autism spectrum also show a great adherence rate of 92.3%. These results suggest that children with developmental conditions may not need to go to a specialized facility for exercise training, and interaction with other children through a structured training environment can bring multiple benefits to their overall development.

## SUMMARY

Like a chromosome packed with the entire genetic information of an organism, traditional martial arts also are packed with various training stimuli, such as balance control, muscle strength, cognitive function, social-behavioral, and philosophy that influence the entire body and the mind. With increasing scientific research describing and confirming the effects of martial arts on the nervous system, functional performance, and mental health, martial arts should not only be viewed as fighting skills as we see and may enjoy in Kung Fu movies. Martial arts are an approachable and holistic therapeutic exercise that provides therapeutic benefits for people of all ages, especially older adults and children on the autism spectrum.

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