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Autism and Martial Arts

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- Neurodevelopment & Inclusion

Feb 3
2024

What is Autism?

- A complex heterogeneous neurodevelopmental disorder [condition?] characterized by
  - + Persistent deficits [diferences?] in social communication and social interaction across multiple contexts
    - Social emotional reciprocity, nonverbal communicative behaviors, relationships
  - + Restricted, repetitive patterns of behavior, interests, or activities
    - Stereotyped/repetitive motor movements, insistence on sameness/routines/rituals, highly restricted/fixated interests, sensorial hyper- or hyporeactivity
  - + Symptoms [traits?] must be present in the early developmental period
  - + Symptoms [traits?] cause clinically significant impairment in social, occupational, or other important areas of current functioning
  - + These disturbances are not better explained by intellectual disability or global developmental delay

American Psychiatric Association; 2013.

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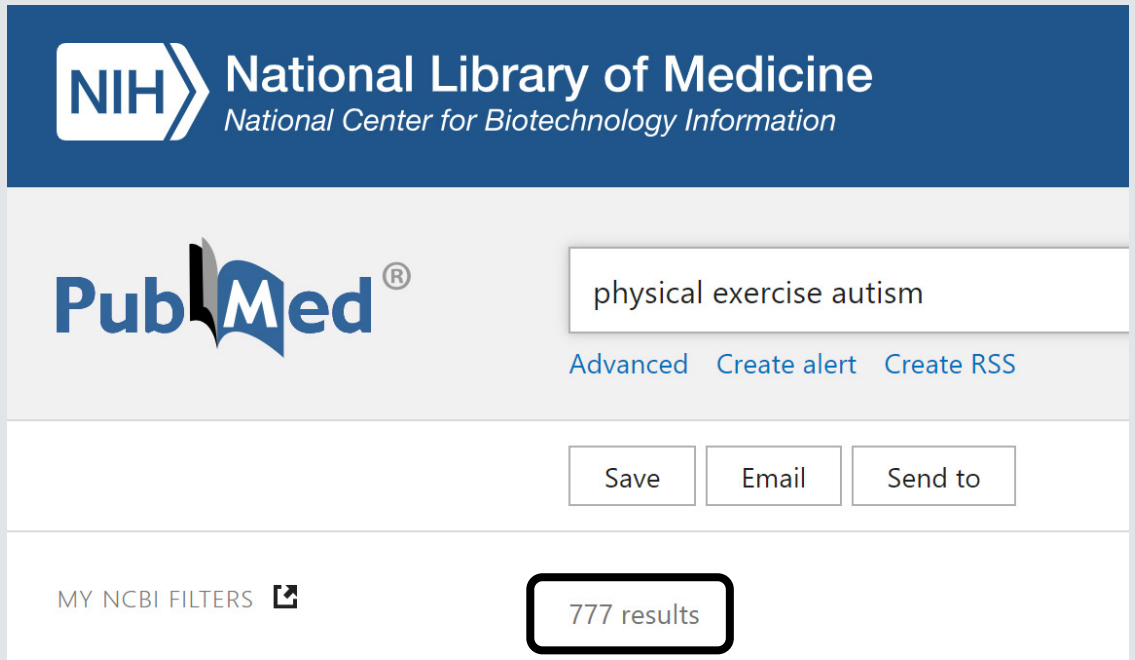
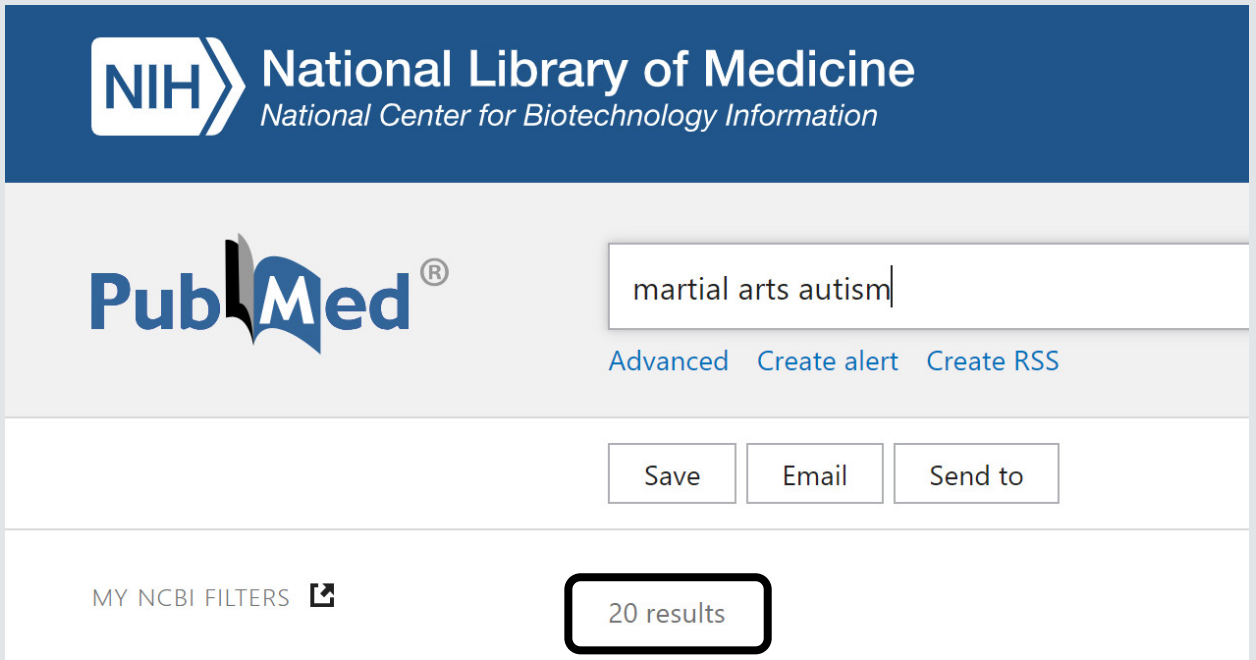
Autism and Martial Arts

What is the evidence?





https://pubmed.ncbi.nlm.nih.gov/

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ASD, Exercise & Physical Activity

Beneficial Use and Potential Effectiveness of Physical Activity in Managing ASD

- Deficiencies in motor skills are associated with ASD and physical activity has been shown to reduce maladaptive behaviors with autistics
- Meta-analysis and systematic reviews have concluded that physical activity has positive effects on social skills and behavior in young children and adolescents with autism
- Activities such as martial arts have been singled out as being particularly beneficial
- Each person affected by ASD has a highly individualized set of symptoms and characteristics for which a highly individualized therapeutic program is warranted

Sefen JAN, et al. Front Behav Neurosci. 2020;14:587560. doi:10.3389/fnbeh.2020.587560

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Systematic review of behavioural outcomes following exercise interventions for children and youth (≤ 16 y.o.) with ASD

- Results indicate that exercise may be an effective intervention for multiple behavioural outcomes in this population
- Exercise may result in a decrease in stereotypic behaviours and improvements in social-emotional functioning, cognition and attention

- Which individual activities resulted in improvements?
  + Jogging, horseback riding, martial arts, swimming or yoga/dance
  + Horseback riding and martial arts interventions may produce the greatest results

Bremer E, et al. Autism. 2016;20(8):899-915. doi:10.1177/1362361315616002

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A Systematic Review of the Effects of Creative Movement Therapies on Social Communication, Behavioral-Affective, Sensorimotor, Cognitive, and Functional Participation Skills of Individuals With Autism Spectrum Disorder

- There is growing evidence for the use of holistic, whole-body, Creative Movement Therapies (CMT) such as music, dance, yoga, theater, and martial arts in addressing the multisystem impairments in ASD
- The strongest evidence, both in terms of quantity and quality, exists for music and martial arts-based interventions followed by yoga and theater, with very limited research on dance-based approaches
- This review of 72 studies (N = 1,939 participants with ASD aged 3-65 years old) suggests there is consistent evidence for:
  + improvements in social communication skills following music and martial arts therapies
  + improvements in motor and cognitive skills following yoga and martial arts training

Amonkar N, et al. Front Psychiatry. 2021;12:722874. doi:10.3389/fpsyt.2021.722874

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A Systematic Review of the Effects of Creative Movement Therapies on Social Communication, Behavioral-Affective, Sensorimotor, Cognitive, and Functional Participation Skills of Individuals With Autism Spectrum Disorder

- ~56% of martial arts studies reported significant improvements in measured outcomes, specifically in social communication, cognitive, and motor domains
- Why?
  - + Heavy emphasis in martial arts training on discipline, structured practice of multistep action sequences, and movement precision, all of which require focused attention, motor planning, task switching, and working memory
  - + Improved synthesis and metabolism of neurotransmitters oxytocin, serotonin, and dopamine
  - + High-energy, dynamic, martial art movement routines are thought to physically resemble stereotypical movements → functional "substitute" for repetitive behaviors, while still providing the same level of sensory input and reinforcement
  - + Practice of poses and action sequences that require good postural control, balance, multi-limb coordination, strength, agility, and optimal processing in the vestibular- and tactile-proprioceptive systems

Amonkar N, et al. Front Psychiatry. 2021;12:722874. doi:10.3389/fpsyt.2021.722874

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A Systematic Review of the Effects of Creative Movement Therapies on Social Communication, Behavioral-Affective, Sensorimotor, Cognitive, and Functional Participation Skills of Individuals With Autism Spectrum Disorder

- "Among all CMT approaches, martial arts-based therapies seem to have the strongest evidence at present for promoting multisystem development in social communication, behavior, motor, and cognitive domains."

Amonkar N, et al. Front Psychiatry. 2021;12:722874. doi:10.3389/fpsyt.2021.722874

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Preliminary Efficacy of a Judo Program to Promote Participation in Physical Activity in Youth with ASD

- Communication deficits, high levels of anxiety, difficulties with social interaction, and preferences for structured and repetitive activities have been associated with low physical activity and high amounts of sedentary time
  + Martial arts may be particularly appealing to ASD: structured format & repetitive exercises
- 8-week judo program to promote moderate-to-vigorous physical activity and reduce (sometimes preferred) sedentary behavior in youth with ASD
- 14 children with ASD (8-17 years old), all attended at least 75% of judo classes. Half of the sample continued participation in judo or a similar martial arts program following the 8-week program
  + Percentage of time spent in daily M-V physical activity (8% vs 4%, p = .05) increased following the intervention, but sedentary time did not decrease significantly

Garcia JM, et al. *J Autism Dev Disord*. 2020;50(4):1418-1424. doi:10.1007/s10803-019-04338-w

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Long-Term Judo Program on Health-Related Physical Fitness of Children with ASD

- 40 children with ASD (mean age 11.07 [±1.73] years) assigned to 6-month judo program (90 min/week) or control group (did not participate in any extracurricular sports activities during this period)
- The judo program tailored for children with ASD can improve the cardio-metabolic health and cardiorespiratory fitness of its participants
- Aspects of judo sessions authors highlight:
  + alternating high- and low-intensity phases, individualized attention, respect for the pace of each participant, explicit verbal and visual instructions, tactile guidance, continuous repetitions and feedback for reinforcement

Pierantozzi E, et al. Int J Environ Res Public Health. 2022;19(24):16731. doi:10.3390/ijerph192416731

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Martial Arts & Social Abilities

The Effect of Karate Techniques Training on Communication Deficit of Children with ASD

- 30 children (age 5-16 years old) with ASD, randomly assigned to exercise (14 weeks of Karate kata techniques) or control group
- Communication scale where caregivers assess how often the child:

(1) Repeats words
(2) Repeats words out of context
(3) Repeats over and over
(4) Speaks with flat affect
(5) Responds inappropriately
(6) Looks away when name called
(7) Avoids asking
(8) Fails to initiate conversation
(9) Uses ‘‘yes’’/‘‘no’’ inappropriately
(10) Uses pronouns inappropriately
(11) Uses ‘‘I’’ inappropriately
(12) Repeats unintelligible sounds
(13) Uses gestures instead of speech
(14) Inappropriately answers questions

Bahrami F, et al. J Autism Dev Disord. 2016;46(3):978-986. doi:10.1007/s10803-015-2643-y

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The Effect of Karate Techniques Training on Communication Deficit of Children with ASD

- Exercise group showed significant reduction in communication deficit compared to control group
- Reduction in communication deficit in the exercise group at 1 month follow up remained unchanged compared to post-intervention time
- Possible mechanisms:
  + Increase in BDNF
  + (tailored) Karate utilizes highly structured and patterned teaching methods while providing high levels of sensory stimulation → stimulate compensatory neural development and recover a child's neurological organization

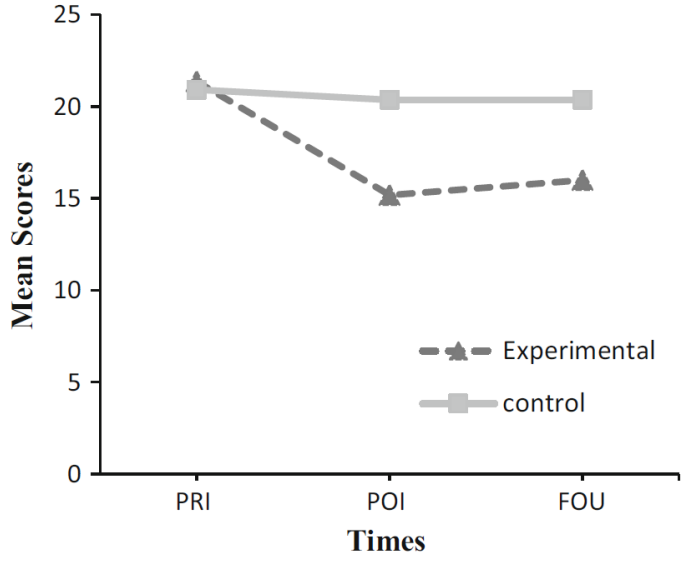

Fig. 1 Mean communication scores of the groups in pre-intervention (PRI), post- intervention (POI), and follow-up (FOU) times

Bahrami F, et al. J Autism Dev Disord. 2016;46(3):978-986. doi:10.1007/s10803-015-2643-y

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The Effect of Karate Techniques Training on Communication Deficit of Children with ASD

- Parents comments:
  - + *‘‘[He] speaks a little more, has developed his sentence structure, and uses more words correctly.’’*
  - + *‘‘He asks more questions than before.’’*
  - + *‘‘He pays more attention to the techniques [during instruction].’’*
  - + *‘‘He seems to interact with others more than before, takes part in group plays and tries to communicate with other children.’’*
  - + *‘‘He greets others more often.’’*
  - + *‘‘He says ‘Goodbye.’’*

Bahrami F, et al. J Autism Dev Disord. 2016;46(3):978-986. doi:10.1007/s10803-015-2643-y

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Impact of Judo on Behaviors and Social Skills of Children With ASD

- 24 students (ages 4-23 years old) with ASD and/or a developmental disability
- 62.5% of parents agreed that their children demonstrated improvement across all six categories:
  + Behavior at home (greatest improvement)
  + Eye contact (least improvement; most variability)
  + Behavior at school
  + Ability to share (most variability)
  + Social skills
  + Performance in school
- No significant improvement in social skills (small sample size)

Lockard BS, et al. Cureus. 2023;15(7):e41516. doi:10.7759/cureus.41516

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Impact of Judo on Behaviors and Social Skills of Children With ASD

- Parents comments:
  - + *“It has opened our eyes to some hope regarding physical activity”*
  - + *“He learned how to play tag with other kids and before he would never acknowledge children”*
  - + *“Judo helped my daughter calm herself and socialize with others”*
  - + *“He loves to assist younger students”*
  - + *“He has social anxiety, so this has helped him a lot”*

Lockard BS, et al. Cureus. 2023;15(7):e41516. doi:10.7759/cureus.41516

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Martial Arts & Behaviour

Effects of a Judo Program on Behaviors in Children with ASD

- 25 children (ages 8–17) with ASD participated in an 8-week judo program (1 × week)
- Participants attended an average of 7.04 ± 1.06 classes (out of 8 sessions)

- 78% of parents observed improvements in both social skills and self-esteem
- 2/3 of parents reported that their child looked forward to the judo class each week

  + No differences between pre- and post-judo in the Aberrant Behavior Checklist → Duration and/or frequency of the judo program? Limitations of the ABC scale (focus on "negative"/challenging behaviors) in mild-moderate forms of ASD?
  + None of the parents noticed any negative behaviors as a result of the program

Rivera P, et al. *Child Psychiatry Hum Dev*. 2020;51(5):734-741. doi:10.1007/s10578-020-00994-7

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Behavioural Improvements in Children with ASD after Participation in a Judo Programme

- 11 children with ASD (aged 9-13 years; IQ 60-70)
- Compared repetitive behaviours, social interaction, social communication, emotional responses, cognitive style and maladaptive speech scores across 4 time-points:
  + Baseline
  + after an 8-week control period
  + after an 8-week judo intervention
  + after an 8-week lockdown period due to COVID-19

Morales J, et al. Int J Environ Res Public Health. 2021;18(16):8515. doi:10.3390/ijerph18168515

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Behavioural Improvements in Children with ASD after Participation in a Judo Programme

- Significant improvements were shown following the judo intervention period compared to the baseline and control periods
- However, the same values significantly declined during the COVID-19 lockdown period resulting in values lower than those recorded at baseline and following the control period and the judo intervention

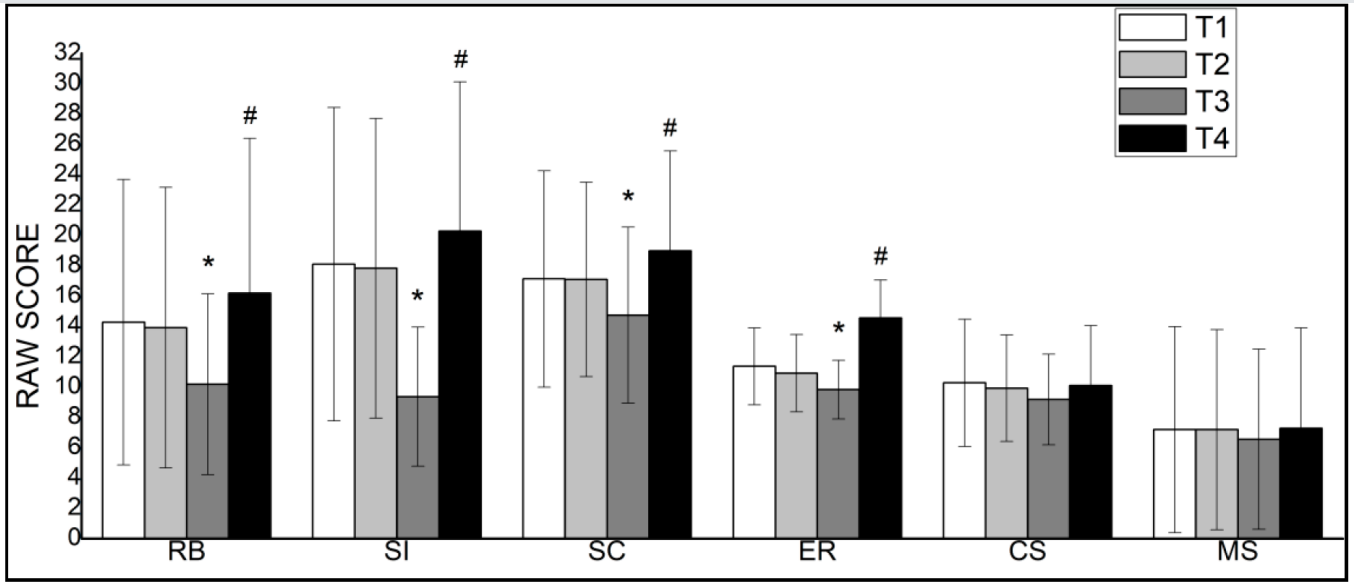

Figure 3. Gilliam Autism Rating Scale-Third Edition (GARS-3) subscales for repetitive behaviours (RB), social interaction (SI), social communication (SC), emotional responses (ER), cognitive style (CS), and maladaptive speech (MS) at baseline (T1-Baseline), after the 8-week control period (T2-Control), after the 8-week judo training intervention (T3-Judo), and after the 8-week COVID-19 lockdown period (T4-Lockdown). * significantly different ($p < 0.05$) from T1-Baseline, T2-Control, and T4-Lockdown. # significantly different ($p < 0.05$) from T1-Baseline, T2-Control, and T3-Judo.

Morales J, et al. Int J Environ Res Public Health. 2021;18(16):8515. doi:10.3390/ijerph18168515

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Transition of a Judo Program from In-Person to Remote During COVID-19 for Youth with ASD

- 9 high school students with ASD
- 8/9 students attended 92% of the remote classes
- All 9 students reported feeling satisfied with the remote judo sessions
- Reported benefits of the remote format included the structured routine during the pandemic and the opportunity for physical activity
- Disadvantages included a lack of space and lack of one-on-one instruction

Garcia JM, et al.. Adv Neurodev Disord. 2021;5(2):227-232. doi:10.1007/s41252-021-00198-7

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Martial Arts & Stereotypy

Some Examples of Stereotypy

https://www.youtube.com/watch?v=4ALy6I1J1uo&t=10s&ab_channel=AutismFamily

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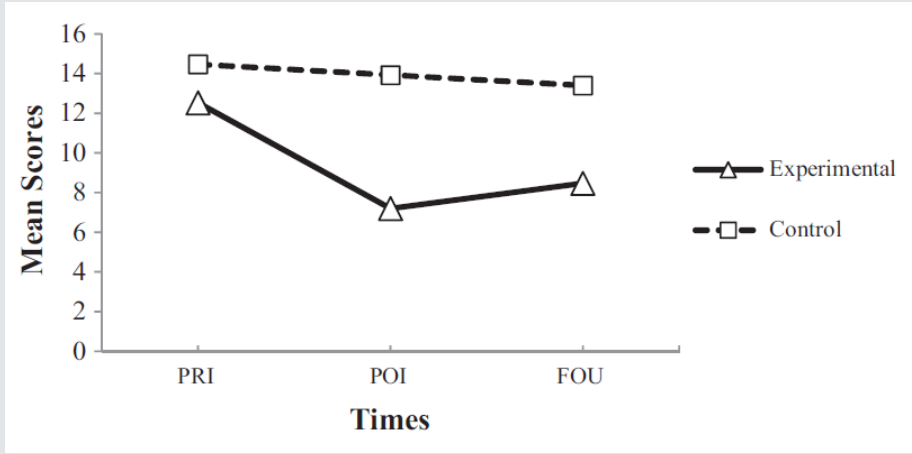
Kata training decreases stereotypy in children with ASD

- 14 weeks of kata training
- 30 children (5-16 y.o.) with ASD
- Exercise versus no-exercise
- Kata techniques training significantly reduced stereotypy (by 42.45%) in the exercise group
- After 30 days of no practice, stereotypy in the exercise group remained significantly decreased compared to pre-intervention time



Mean stereotypy scores of the groups in pre-intervention (PRI), post-intervention (POI), and follow-up (FOU) times.

Bahrami F, et al. Res Dev Disabil. 2012;33(4):1183-1193. doi:10.1016/j.ridd.2012.01.018

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Kata training decreases stereotypy in children with ASD

- Is this an effect of exercise in general or specific to Kata?

  + Stereotypic behaviors have been shown to decrease immediately after physical exercise, but gradually increase and return to baseline levels over a 40-90 min period of rest

  + The resemblance between stereotypic behaviors and Kata techniques may account for the more stable reductions of stereotypy in this study, which were maintained in the post-intervention follow-up at 30 days

Bahrami F, et al. Res Dev Disabil. 2012;33(4):1183-1193. doi:10.1016/j.ridd.2012.01.018

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The Effect of Tai Chi Chuan Training on Stereotypic Behavior of Children with ASD

- 23 participants (mean age = 9.60 ± 1.40 years)
- 12 weeks of Tai Chi versus control (not defined)
- Stereotypic behavior was significantly altered by ~25% in the Tai Chi group
- Behavioral change was maintained at follow up (1 month)
- Proposed mechanisms:
  + Stress reduction, autonomous nervous system modulation (↓S, ↑PS), cortisol/serotonin/oxytocin effects
  + “In mind–body exercises, especially martial arts, there is forced concentration on the movements”

Tabeshian R, et al. J Autism Dev Disord. 2022;52(5):2180-2186. doi:10.1007/s10803-021-05090-w

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The Effect of Tai Chi Chuan Training on Stereotypic Behavior of Children with ASD

- "In mind-body exercises, especially martial arts, there is forced concentration on the movements"
  - + *In martial art exercises every step and movement is the sign and trigger for the next movement in an ongoing chain. With stereotypic movement the trigger is internal and repeated. It is suggested that the contrast between external and inner sensorimotor cues may help break the internal reverberation and drive positive neuroplasticity in the direction of movement stabilization*
  - + *Physical activity which includes motions similar to that found in stereotypic movement patterns but which are deliberately generated as part of an intentional motor task may provide similar sensory feedback that may stabilize stereotypy*

Tabeshian R, et al. J Autism Dev Disord. 2022;52(5):2180-2186. doi:10.1007/s10803-021-05090-w

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Martial Arts & Motor Balance and Skills

Overview of Intervention Strategies for Postural Balance Control in Individuals with ASD

- Different forms of martial arts have been frequently used to improve postural balance in individuals with ASD
  - + Karate kata (static and dynamic balance) → static stability, body equilibrium, alignment and awareness, muscle strength
  - + Tai Chi Chuan (ball skills, static and dynamic balance) → cognitive-motor exercise, neuromuscular coordination enhancement, anxiety control
  - + Taekwondo (only significant for right single leg stance, but small sample) → knee extensor muscle strength and standing on one leg during kicking

Hariri R, et al. Autism Res Treat. 2022;2022:3639352. doi:10.1155/2022/3639352

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Aquatic Versus Kata Training on Static and Dynamic Balance in Children with ASD

- 30 children (8-14 years old) with ASD
- 3 groups: karate exercise, aquatic training and control groups
- Participants practiced for 10 weeks, 2 sessions of 60 min per week
- Both interventions had a significant effect on balance abilities
  + Greater improvement in balance performance in kata techniques group

  + Water properties (e.g. buoyancy, relative density, resistance) may provide a more enjoyable, safer, and easier environment, relieve weight, provide postural support, strengthen and facilitate motor skills
    - So why was kata associated with greater improvement in balance?

Ansari S, et al. J Autism Dev Disord. 2021;51(9):3180-3186. doi:10.1007/s10803-020-04785-w

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Aquatic Versus Kata Training on Static and Dynamic Balance in Children with ASD

- So why was kata associated with greater improvement in balance?
  + Cooperation of postural muscular responses; better efficiency in vision, vestibular and somatosensory (proprioceptive) systems; improved muscular strength and range of motion; and better physical structure

  + *"The development of body awareness is the most often reason why Martial arts enhance balance."*

Ansari S, et al. J Autism Dev Disord. 2021;51(9):3180-3186. doi:10.1007/s10803-020-04785-w

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Tai Chi Chuan training on the motor skills of children with ASD

- 18 children with ASD (ages 6-12 years old) were divided randomly into experimental (6-week program consisting of 18x60 min sessions) and control (did not carry out any regular exercise training) groups
- Significant difference in the subscales of ball skills (throwing and catching) and balance performance (static and dynamic) but no difference in the manual agility scale (speed of movement, motor coordination of hands, and hand-eye coordination) between the two groups
- Why?
  + Slow motion workouts with strongly focused attention may lead to developed control of body motions with harmony and discipline

Sarabzadeh M, et al. J Bodyw Mov Ther. 2019;23(2):284-290. doi:10.1016/j.jbmt.2019.01.007

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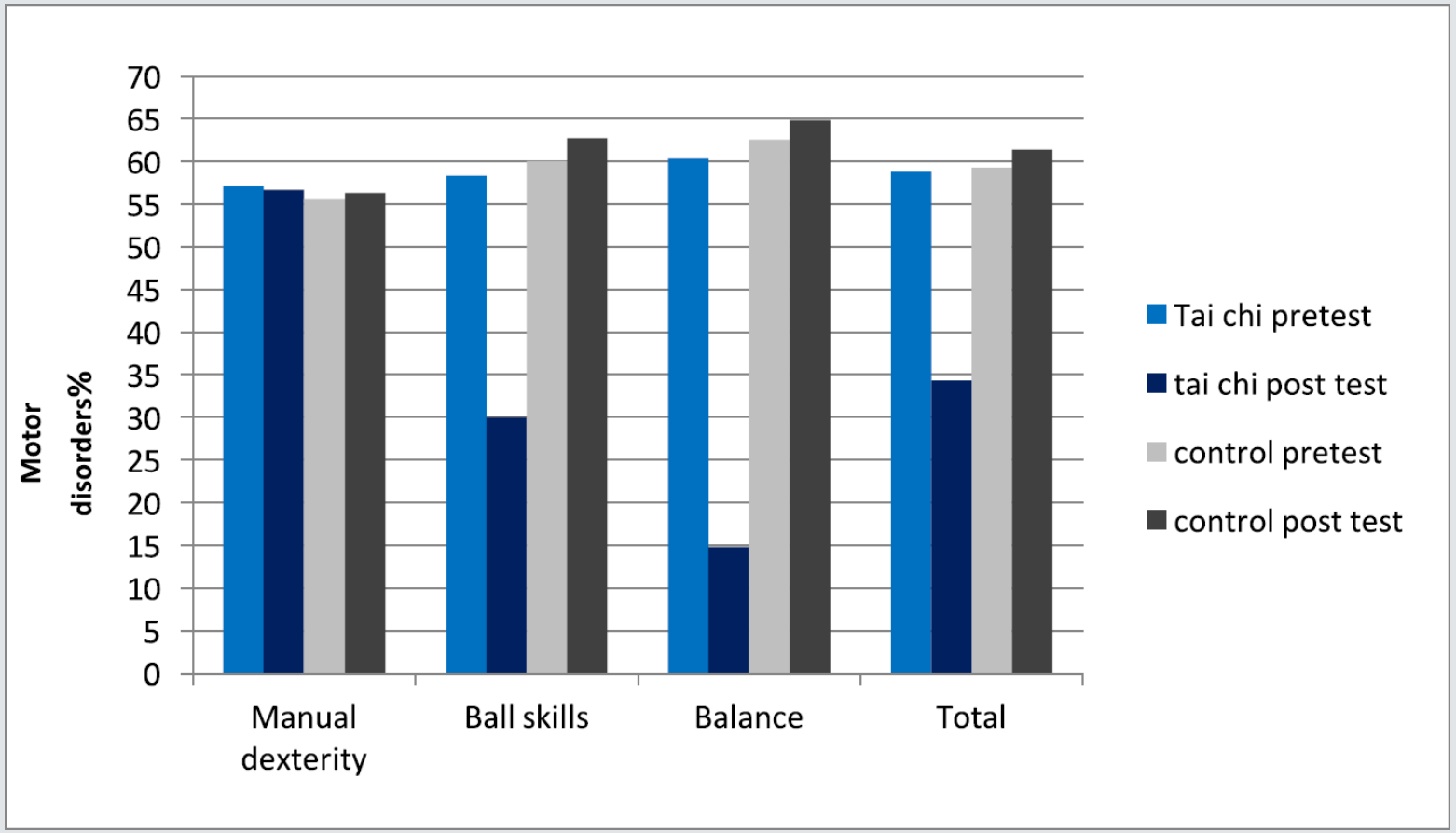
Tai Chi Chuan training on the motor skills of children with ASD



Sarabzadeh M, et al. J Bodyw Mov Ther. 2019;23(2):284-290. doi:10.1016/j.jbmt.2019.01.007

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Tai Chi Chuan training on the motor skills of children with ASD

- Other benefits associated with Tai Chi Chuan (from different studies)
  + Better behaviour control (ability to sit for a long period of time)
  + Improved ability to self-regulate and cope with change
  + Improvement of hand-foot coordination, muscular tone, sensory homogeneity, body awareness, and particularly self-confidence in autistic children

  + Mind-body exercise → neurocognitive enhancement and CNS connectivity → more organized and better maintenance of information during memory processing → improvement of neuromuscular coordination in motor skills in autistic children

Sarabzadeh M, et al. J Bodyw Mov Ther. 2019;23(2):284-290. doi:10.1016/j.jbmt.2019.01.007

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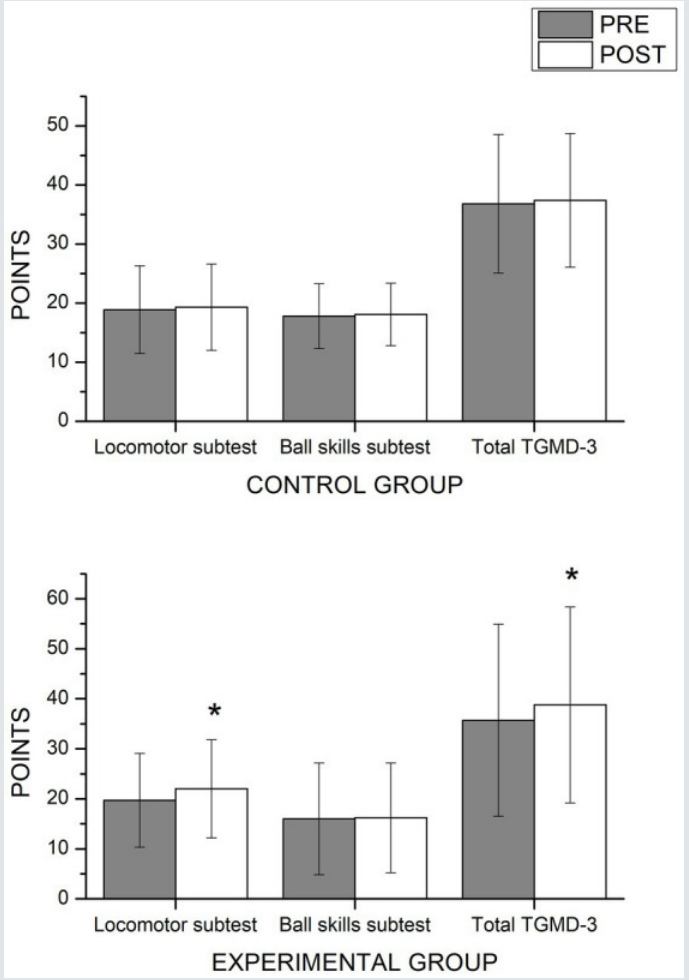
Improving motor skills and psychosocial behaviors in children with ASD through an adapted judo program

- 40 children with ASD (mean age of 11.07 [±1.73] years)
- Experimental versus control group
- Assessment at baseline and after 6 months (1 90-min session per week)
- Significant improvement from pre-test to post-test in motor skills and psychosocial behaviors (rep. behav., soc. inter., emot. resp., cog. style)

(GMD, gross motor development)



Morales J, et al. Front Psychol. 2022;13:1067310. doi:10.3389/fpsyg.2022.1067310

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Improving motor skills and psychosocial behaviors in children with ASD through an adapted judo program

- Judo program based on the principle ““normal where possible, adapted where necessary”
- Warm-up → judo-specific content (gradual progression) → cool-down
    - Different types of general movements and falling techniques (from stepping in all directions to body repositioning and turning, movements from stable to unstable supports)
    - Simplified judo-specific movements and games (building up body contact through games, primary focus on essential/simplified judo movements)
    - Body control techniques on the ground and throws (progression of techniques from simplified to more complex movements)
    - Repetitions of basic technical movements in different directions (pulling, pushing, holding, lifting)

Morales J, et al. Front Psychol. 2022;13:1067310. doi:10.3389/fpsyg.2022.1067310

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Improving motor skills and psychosocial behaviors in children with ASD through an adapted judo program

- Judo program based on the principle ““normal where possible, adapted where necessary”
- Warm-up → judo-specific content (gradual progression) → cool-down
  - The learning method chosen was imitation. The instructor presented techniques and then guided the practice
  - The employment of very marked routines based on brief and clear instructions in the form of the five “W” (who, when, what, where, why)
  - Judo teachers spoke in a calm and firm voice. They gave objective instructions and refrained from using figurative language or irony
  - It can be deduced that sometimes it can be difficult for people with ASD to see the big picture because they perceive so many details
  - Instructors were trained to keep calm and not criticize the slowness of reproducing movements that sometimes characterize people with ASD
  - Spontaneous and unexpected behavior changes were monitored and redirected by judo teachers. They were aware that each participant required their own time
  - Instructions were given repetitively and employed a broad spectrum of senses, not only verbal cues. The isolated use of sensory instructions, one at a time, can support perception. For example, the instructor may physically demonstrate with verbal instructions and once without speaking

Morales J, et al. Front Psychol. 2022;13:1067310. doi:10.3389/fpsyg.2022.1067310

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Improving motor skills and psychosocial behaviors in children with ASD through an adapted judo program

- Judo extends beyond physical activity, with additional emphases on self-discipline and behavioral, emotional and cognitive control
- Judo programs can positively affect social functioning and physical health
- Development of motor skills → participation in other sports and physical activity programs with neurotypical peers
- Judo is a combination of peer learning (improves relationships among students) and guided activities (learning through imitation)
- Structure and formal procedures, including bowing, might help participants overcome some of the difficulties they face in their everyday lives and at school

Morales J, et al. Front Psychol. 2022;13:1067310. doi:10.3389/fpsyg.2022.1067310

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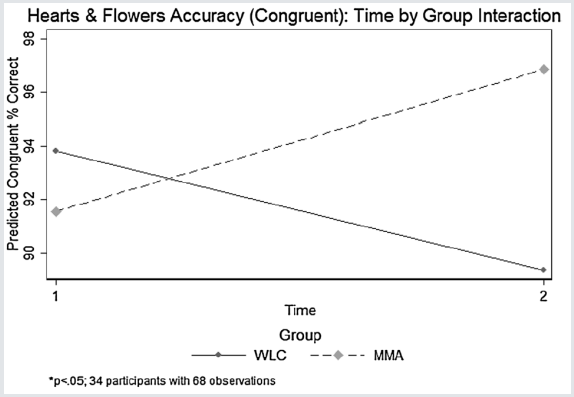
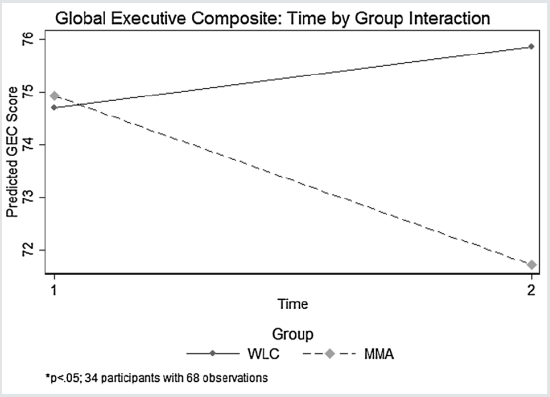
Martial Arts & Executive Functioning

Promoting Executive Functioning in Children with ASD Through Mixed Martial Arts Training

- 34 children with ASD (8-11 years old), randomly assigned to MMA (26-class program over a 13-week period) or a waitlist control (no martial arts training)
- The MMA group had significantly better executive functioning (inter-related cognitive processes that drive goal-directed behaviors) at post-test vs WLC group
  + Hearts & Flowers Test: behavioral inhibition, working memory, and cognitive flexibility
  + Behavior Rating Inventory of Executive Function (Behavior, Emotion, and Cognitive Regulation Indexes)





Phung JN, Goldberg WA. J Autism Dev Disord. 2019;49(9):3669-3684. doi:10.1007/s10803-019-04072-3

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Conclusions and Open Questions

- Consistent benefits of martial arts training in core symptoms of ASD
  + Social communication and social skills
  + Stereotypy, balance & motor skills
  + Executive functioning
- Several proposed mechanisms, but intrinsic characteristics of martial arts (structure, repetiveness, mind-body integration) seem relevant and provide distinct (and enduring) results compared to other types of physical exercise
- Evidence mostly from children/adolescents – will we see similar effects in autistic adults?

BIAS
BUILDING AN INCLUSIVE ATTITUDE IN SPORT

Thank you!

João Miguel Fernandes, Psych.

- Neurodevelopment & Inclusion

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