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Systematic Review of the Impact of Tai Chi and Qigong on Children with Neurodiversity

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Abstract: There is evidence that Tai Chi and Qigong (TC&Q) are beneficial for health challenges of adults. However, evidence for children is sparse. The purpose of this research is to find and evaluate any available evidence. We ask about the prevalence of studies, the type of outcomes, the level of quality, and if we can draw conclusions from what we find. This systematic review follows PRISMA 2020 guidelines (https://www.crd.york.ac.uk/PROSPERO/view/CRD420251114754. From 785 articles, 45 articles met the original criteria. Descriptive data on the 45 articles is reported. A revision of the criteria netted 10 studies on TC&Q for children with neurodiversity. More detailed analysis and quality assessment was performed on them. From the 45 initial studies from16 countries, China produced 29% of the studies. Portugal and the USA had 13%. Most (64%) were RCTs, ranging from 3 to 231 subjects and a large variety of durations, lengths, and frequencies with 122 different outcomes measurements. For the systematic review of 10 studies, generally the quality of the studies was high. The areas of concern for two of the studies was reporting incomplete data. Four of the studies did not blind the assessors, and only one of the studies blinded the participants. The average effect size when compared to controls was 1.01 (±.34) (CL of 95%). When looking at the effect size for the pre-tests with the post-tests, the effect size is 1.71 (±.62) (CL of 95%). A

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large effect size does not necessarily a significant finding as Another result was the percentage of studies with significant findings. Most of the outcomes (69.4% of them) were significant at the .05 alpha level showing an effective TC&Q intervention. Keep in mind that some of the studies did not find significance for the experimental group, but did find significance for the control group which was Tai Chi or Qigong. There are more studies on TC&Q and children than we had realized. TC&Q studies of children with neurodiversity are relatively high quality. Furthermore, TC&Q interventions have a large impact on children with neurodiversity. These impacts are equal, or superior, to other types of interventions.

Despite the variety of interventions, durations, frequencies, and outcomes, it can be safely concluded that in most cases there is a preponderance of evidence that children with neurodiversity may benefit from Tai Chi and Qigong practices on all three aspects; physical, psychological, and behavioral. Of course, further research needs to be done with more standardized interventions, durations, frequencies and outcomes to be able to ensure a more solid weight of evidence. Systematic Review Registration: Prospero CRD420251114754

Keywords: Children, Adolescents, Tai Chi, Qigong, Mental Health, Physical Health, Psychosocial, Benefits

Introduction

In an increasingly stressful world with rising chronic health challenges, it is important to do all we can to start early in preventing and mitigating issues in mental and physical health. There has been a great deal of research done on the benefits of Tai Chi and Qigong for adults and older people, but to date there hasn't been a concerted effort to pull together research done on Tai Chi and Qigong for children. Furthermore, psychosocial development appears to be a dominant theme, specifically neurodiversity. Children with neuro diversity may well benefit from Tai Chi and Qigong even more so than the general population of children.

The purpose of this systematic review is to identify what studies, if any, have been done regarding Tai Chi and Qigong for children with neurodiversity, and to assess the quality of those studies. Furthermore, what conclusions can be drawn on the impact of Tai Chi and Qigong for those children with neurodiversity?

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Background and Rationale

Based upon the research done on adults, there are many health issues in children and adolescents for which Tai Chi and/or Qigong might be therapeutic and beneficial. These health issues fall under a few categories: mental health disorders, psychosocial issues, and physical issues. Of all the different challenges children face, neurodiversity, a psycho-social issue, has a severe impact on their whole lives. Additionally, there appears to be numerous studies on Tai Chi and Qigong's impact on children with neurodiversity. Therefore, after an initial discussion of all the studies found on Tai Chi and Qigong and children, this systematic review will focus specifically on this subgroup; children with neurodiversity. Research on Tai Chi and Qigong for children with neurodiversity is critical in order to deal with the complex interaction of genetic, environmental, and psychosocial factors that influence neurodiversity issues.

Previous systematic reviews on Tai Chi and children have focused on a much wider definition for the intervention, often including any massage, martial art and/or mind-body activity. None have focused exclusively on Tai Chi and Qigong for the benefit of children with neurodiversity between the ages of 3 and 19 years of age (inclusive). Targeted research is needed to develop effective interventions for the benefit of children with neurodiversity challenges.

There are both practical and clinical applications of this research. Public policymakers for the health and wellbeing of children should be aware of any and all evidence there might be regarding the impact of Tai Chi and Qigong on children with neurodiversity. It is important for policy makers and health professionals to understand the benefits of Tai Chi and Qigong, so that they may integrate this information into the programs of children with neurodiversity under their care.

Terminology and Definition: Tai Chi and Qigong

Doing research on Tai Chi and Qigong is very challenging. Many of these challenges were addressed in the National Expert Meeting on Qi Gong and Tai Chi Consensus Report which listed fourteen barriers to the process of diffusing programs in the community. Among them: lack of public and professional knowledge of the health benefits and the need for more controlled clinical trials to document those health benefits [1].

One of the largest barriers to finding research on these topics is the lack of standardization on the terminology surrounding Tai Chi and Qigong. The

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public is often unsure and/or confused about what Tai Chi and Qigong is. There is controversy among the Tai Chi and Qigong community about the definitions and relationships among the terms which makes it that much more difficult for everyone.

For purposes of this study, Tai Chi and Qigong is defined as both physical and mental practices that involve both movement and meditation/relaxation. They are considered mind-body activities, based on ancient Chinese philosophies that are purported to promote both mental and physical health, leading to longevity.

Tai Chi and Qigong can include complex choreographed sets of movements or "forms", but they can also be simple and easy-to-learn movements and thought patterns. The components that are essential to the practice are:

- Body posture adjustment and gentle movement
- Intention (often meditative) and purposeful relaxation
- Breath (deep breathing) focus and practice

These components integrate into in a multitude of activities, resulting in a wide variety of movement from dynamic and vigorous to slow and meditative. These activities can be practiced walking, standing, sitting, or lying down. Tai Chi can also include weapons forms (sword, staff, fan) and a two-person form (Da Lu) or push hands (Tui Shou, also called sensing hands). Qigong can also include self-massage and meditation.

When practiced by children, Tai Chi is often called Kung Fu, usually a bit more dynamic and less meditative than typical Tai Chi. Qigong and Tai Chi practices don't always use those labels. Qigong can be referred to by the specific Qigong form such as Baduan Jin, Eight Brocades, Five Animals, Choy Lee Fut Hung Sing Gwoon, Yan, Daoyin, Nei Gong, Chen, Yi Jin Jing. Tai Chi can be referred to by the Family Styles; Yang, Chen, Sun, Wu, and Wu Hao or some other variant of the original five styles.

Terminology and Definition: Neurodiversity

Neurodiversity is a relatively new term used in a wide variety of domains, and its use is growing exponentially [2]. Initially applied narrowly to just autism, neurodiversity has expanded into an umbrella term including all the components of human brain developing such as attention, language, communication, socialization, learning, and motor movement that impacts up to 20% of the world's population [3, 4]. Neurodiversity is defined both as a neurodevelopmental

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disorder (autism, attention deficit hyperactivity disorder, learning disabilities, intellectual disabilities, etc.) formally diagnosed with DSM-5 or ICD-10/11 and as a mental health condition (such as depression, anxiety, and behavioral issues) as they impact learning. These disorders may include biomedical outcomes as well as self-report such as quality of life assessments reported by the subject, parents or teachers.

However, there is a growing movement to treat neurodiversity not as a disability or challenge or disorder, but rather simply as a different way of thinking [5]. Researchers call for future directions which include accepting neurodiversity, evaluating the effectiveness of neurodiversity-affirming strategies, and exploring the effect of the neurodiversity paradigm on mental health outcomes [6].

Regardless of the politics of the term, the importance of working with neurodiverse children is emphasized in this research. There could be potential benefits of integrating Tai Chi and Qigong into the paradigm of helping children with neurodiversity.

Previous Research of Tai Chi and Qigong

Tai Chi and Qigong are practiced world-wide by a variety of people. Radmark, et al, utilized records from 8716 respondents to the Swedish Longitudinal Occupational Survey of Health in a cross-sectional study and found that 783 people (9%) practiced bodily mind/body practices such as yoga, Tai Chi, or Qigong. Of those people, 189 (24%) did it on a regular basis. [7]. While still dwarfed by other mind-body therapies, Tai Chi and Qigong is practiced by 1.3% of the United States population; 2794 of the respondents in the 2008 National Health Interview Survey [8].

There is a preponderance of evidence that Tai Chi and Qigong are beneficial for a variety of health challenges faced by adults, especially older adults. Wayne and Fuerst laid a very strong foundation of scientific evidence for Tai Chi and Qigong in their the book The Harvard Medical School Guide to Tai Ch [9]. Bagalev, Pirovski, N. and Pirovski A. conducted a review of 600 articles in 2011 and found 38 that led them to the conclusion that Tai Chi has positive health benefits with no side effects, and recommends more than 5 hours a week for at least 12 weeks as optimal [10]. Morgan, et al, found that mind-body practices like Tai Chi and Qigong had an effect on C-Reactive Protein levels, which is linked to increased risk for metabolic syndrome, cardiovascular disease, and mental disease. [11]. The list could go on and on, as a growing raft of studies find positive

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benefits for Tai Chi and Qigong - among adults.

However, the evidence for the use of Tai Chi and Qigong among children is sparse compared to the evidence for the use of Tai Chi and Qigong for adults. But there has been some.

We found several systematic reviews that included Tai Chi and Qigong for children. Romero-Garcia, et al, did a comprehensive literature review of Complementary and Alternative Medicine practices for children and found potential benefit for tai chi for children among many other Complementary and Alternative practices [12]. Liu, et al, did a systematic review of Tai Chi and Qigong and the psychological well-being of adolescents and concluded that there was beneficial effect of Tai Chi and Qigong on reducing anxiety, depression and cortisol levels, but not stress, mood, or self-esteem [13].

Gutierrez-Domingo, et al, concluded that mindfulness-based interventions may be a viable strategy to help with anxiety, distress, depression, self-efficacy, well-being, and quality of life for young people with diabetes [14]. Sapthiang, Gordon and Shonin concluded after a systematic review that school-based mind-body interventions have a range of benefits to mental health, according to students themselves [15]. Zhang, et al, did a review in 2012 of the psychological effectiveness of Tai Chi on different populations and discussed four studies directly related to children and teens, though commenting on the poor quality of the studies at that time.[16]

Kretschmer, Tebrizicik, and Dommett found in their systematic review of ADHD and mindfulness interventions that there were possible benefits on self-compassion, quality of life, wellbeing, depression, emotional dysregulation and anxiety [17]. Field included Tai Chi in her research of therapies for children and adolescence, and discussed ten different studies outlining benefits such as a decrease in anxiety, depression, and improved mood. Field also discussed the physical improvements from Tai Chi for children, which included decreased stress hormones, improved pulmonary function, and vagal activity such as decreased heart rate as well as behavioral improvements from Tai Chi for children, which included increased attentiveness, improved sleep, and decreased hyperactivity [18].

Kretschmer, Tebrizicik, and Dommett also found in their systematic review of ADHD and mindfulness interventions that ADHD symptoms, executive function, and problematic behaviors may be improved [17]. Herbert and Esparham also found help for ADHD children and discussed three

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studies on Tai Chi that improved symptoms of ADHD [19].

It was due to the large number of studies on ADHD and Autism that we decided to focus on neurodiversity as a specific

Research Questions

To date, there have been several systematic reviews on Tai Chi and Qigong and children, but no systematic reviews have been done on the impact of Tai Chi and Qigong on children with neurodiversity. The questions we are asking:

- How prevalent are studies focusing on Tai Chi and Qigong for children?
- What types of outcomes are measured by those studies, and are they bio-medical based or self-assessed?
- Among them, what studies, if any, have been done regarding the impact of Tai Chi and Qigong for children with neurodiversity?
- What level of quality can be found among those studies?
- Can any conclusions be drawn based on the preponderance of evidence provided by these studies?

Method

The purpose of this systematic review is to assess the impact of Tai Chi and Qigong interventions on children who have neurodiversity. Our phase 1 search focused on finding all studies involving Tai Chi and Qigong and children. We limited the interventions to classic Tai Chi and Qigong, which means we excluded other external martial arts or mindfulness-only forms of Qigong. In phase 1 we looked at all potential conditions and outcomes. The relevant ages of the children was limited to 3 19 years of age, excluding infants and young adults but including young children and adolescents.

This systematic review followed the process recommended in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 updated guidelines [20, 21]. It is registered as PROSPERO 2025 CRD420251114754. Available from https://www.crd.york.ac.uk/PROSPERO/view/CRD420251114754

Two Phases; Both Results Reported

Electronic database search of titles and abstracts were conducted using EBSCO's "Search Everything" Tool. The search string used was (TI ("Tai chi" or Taiji or "Tai ji" or "T'ai Chi Ch'uan" or Taijiquan or Qigong or "Chi Kung" or "Qi gong") AND TI (children or youth or child or teenager or adolescent)) OR (AB ("Tai chi" or Taiji or "Tai ji" or "T'ai Chi Ch'uan" or Taijiquan or Qigong or "Chi Kung" or "Qi gong") AND

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AB (children or youth or child or teenager or adolescent)) Additionally, several websites and two registers (PROSPERO systematic reviews and clinicaltrials.gov) were searched using equivalent search terms. All of the references were exported into the Rayyan tool [22] and further reviewed for potential inclusion list.

We initially included randomized controlled trials, non randomized trials, cohort studies, pilot and feasibility studies, as well as case studies, and included all populations of children, because we did not expect to find many studies. We were surprised when we found 45 studies on Tai Chi and Qigong and children that met the wider initial criteria. We took the opportunity this situation provided to us to focus more directly on just one of the domains under the larger search; neurodiversity. However, we will provide some descriptive statistics on the original 45 studies as background information before delving into assessing the quality of the specific studies on neurodiversity.

There could be several reasons why earlier searches did not reveal that many studies, while this one revealed a healthy number of studies. For one, we did not need to limit our studies to any particular language due to new AI translation tools such as DeepL Pro, so we were able to expand our search into any language, not just English or Chinese. Second, our use of new search technologies such as the "Search Anything" was able to search many more databases simultaneously than previously available. In previous searches, we had to choose specific databases to search, which were necessarily limiting in time and scope.

Inclusion and Exclusion Criteria

The inclusion criteria for the final set of studies was:

- Random control trials.
- Tai Chi, or Qigong, or Mindful Martial Arts used as either an intervention or a control. Qigong includes well-known qigong-based movements such as Baduan Jin (8 Brocades), Choy Lee Fut Hung Sing Gwoon Kung Fu, Daoyin, Nei Gong, Peace Power, White Ball, Xianggong, Laughing Qigong, Yi Jin Jing, Zhang Yuan, etc.
- Children between the ages of 3 and 19 (inclusive) with neurodiversity.

Note that this final addition, "with neurodiversity" was added only in the second phase.

The exclusion criteria for the final set of studies was:

- Non-random trials or trials without controls, Case Studies, Qualitative studies, Protocol only.

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- Qigong Sensory Massage (which is not Qigong self-massage, but applied by a second person), any non-movement mindfulness activity, any general external martial art bearing no similarity to Tai Chi.
- Children who did not exhibit one or more of the characteristics of neurodiversity.
- Young adults 19 years old or older.
- Children age 2 or under.

Neurodiversity is defined as a neurodevelopmental disorder (autism, attention deficit hyperactivity disorder, learning disabilities, intellectual disabilities, etc.) formally diagnosed with DSM-5 or ICD 10/11 as well as children's formally diagnosed neurodiverse mental health conditions of (such as depression, anxiety, self-esteem, self-concept, and behavioral issues) as they impact learning. These disorders may include biomedical outcomes as well as self-report such as quality of life assessments reported by the subject, parents or teachers.

Risk of Bias

The studies will be evaluated utilizing the ROB 2 assessment criteria [23]. One author did an initial assessment, and the other four authors independently reviewed to either confirm or refute the assessment of each domain. After assessment, authors met to discuss differences in assessment and discussed to come to consensus on the final assessment for each of the articles.

Results

Systematic Search Results

The PRISMA flow chart is shown in Figure 1. As explained earlier, there was an initial set of 45 reports which will be described in general terms, but only the specific set of final reports on studies of children with neurodiversity will be included in the systematic review. The exclusion reason, therefore, is given in two different places. The initial exclusion of 171 records is explained under the flow chart.

The databases in which the initial 561 studies were found are listed in Table 1.

Table 1. Databases where studies were found

Medline (93)
Complementary Index (76)
Academic Search Ultimate (56)
CINAHL Complete (49)
Gale Academic OneFile (44)
APA PsycInfo (44)
Supplemental Index (31)
Science Citation Index Exp. (23)

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SPORTDiscus with Full Text (22)
ScienceDirect (21)
Gale Health and Wellness (15)
Social Sciences Citation Index (15)
Education Source (15)
Springer Nature Journals (13)
Biological Abstracts (11)
Gale Academic OneFile Select (11)
Health Source: Nursing/Academic Edition (11)
SocINDEX with Full Text (9)
Psychology and Behavioral Sciences Collection (8)
Gale in Context: Science (5)
Gale eBooks (5)
ERIC (5)

Gale In Context: Opposing Viewpoints (4)
Gender Studies Database (4)
Teach Reference Center (3)
Business Source Complete (2)
JSTOR journals (2)
ACM Full-Text Collection (1)
Credo Reference (1)
Gale in Context: College (1)
HeinOnline (1)
Arts & Humanities Citation (1)
GeoRef (1)
Library, Information Science and Technology with Full Text (1)

Note. Number of records totals to 604 due to the same article appearing in multiple databases.

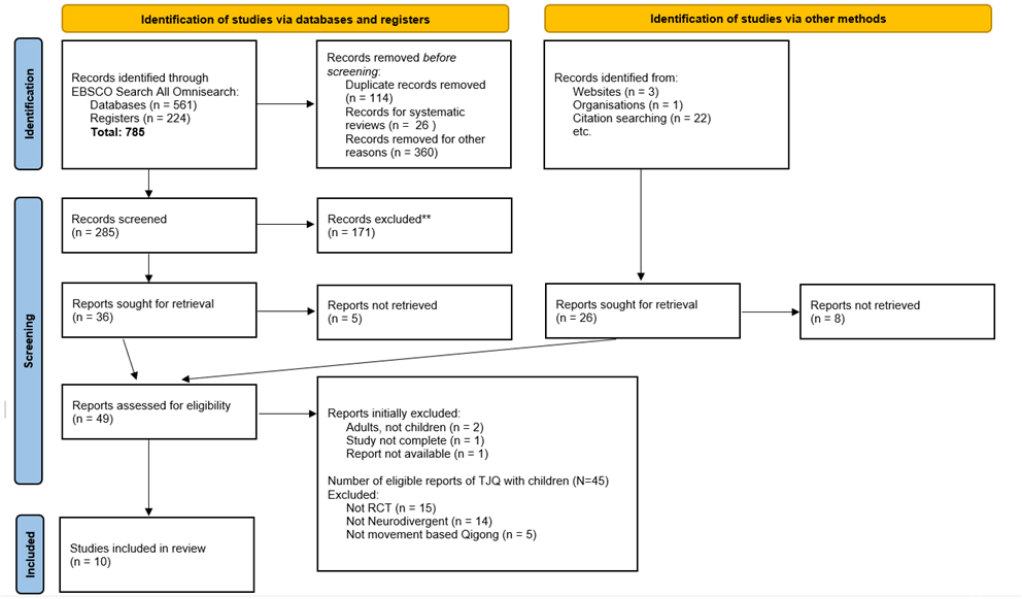

Figure 1. PRISMA Flow chart of Search

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Note. Number of records totals 206 due to multiple reasons for exclusions on the same article. **Reasons for exclusions (171) at first level of screening: Review (43), Not Tai Chi (69), Not children (32), Just a protocol (19), Qualitative only (5), Backgrou After initial review of the titles and abstracts of the original 785 articles, 144 reports were pulled for potential articles of inclusion and related systematic or other type of review. The 144 reports were independently reviewed by two authors (CJR & JD) and discussed until agreement was reached on 36 articles to be further reviewed.

The references of the 144 reports were then manually reviewed for additional potential items. An additional 22 more items were added, as well as 4 items identified manually by the authors (CJR, JD, JR, WL, DR, JM). That left 49 articles to be screened in full text by all authors. Each author independently reviewed the 49 articles for potential inclusion and then met to discuss differences in choices. Of those 49, after discussion 4 more were excluded leaving 45 articles that met all the original criteria. Descriptive statistics which the authors felt might be useful to other researchers were reported in the results.

Second Phase: Focus on Neurodiversity

It was at this point that the authors chose to focus on one population so that a more in-depth systematic review could be done on just one domain, one that appeared to have the most promise for helpful benefits. After reviewing the possibilities within the populations and outcomes, it was determined that the largest subset was neurodiversity.

Given that neurodiversity is a relatively new term, none of the studies specifically used that label. But the definition of neurodiversity would include several of the populations of the studies (autistic spectrum disorder, attention deficit hyperactive disorder, learning disabilities, etc.) The definition would also encompass several of the outcomes (stress, memory, self-concept). That led to 14 studies. However, after further discussion the authors decided to focus solely on the population, children with neurodiversity, rather than the outcomes. The four studies that were neurodiverse based on outcomes were then excluded, leaving 10 random control studies to focus on.

The final 10 articles, then, were chosen for inclusion. One author (CJR) extracted the data and created the Excel spreadsheet that was confirmed by four other authors (RJ, DR, JM, WL).

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Descriptive Statistics of Initial Phase Reports

The statistics of the initial 45 studies is informative. In this section we reported on the countries, domains, populations, types of studies, sizes, age ranges, descriptions of interventions, dosage, controls and outcome measurements from the larger set of studies.

Countries and Domains

Initially striking is the number of countries (16) represented by these studies. While the largest number came from China, it was surprising to see just as many from Portugal as from the United States. Many countries had just one study. nd article (70)

Table 2. Countries represented by studies.

Country	**Count**
China	13
Portugal	6
USA	6
Canada	4
Taiwan	3
Country	**Count**
Australia	2
Iran	2
Argentina	1
Germany	1
Hong Kong	1
Country	**Count**
India	1
Lithuania	1
Russia	1
Sweden	1
Tunisia	1
Turkey	1

Also of note is the wide variety of domains (either population or outcomes) involved in these studies shown in Table 3. Where the outcome is listed (such as Stress Reduction, Self Concept, Attention, etc), the population was normal children. In all other cases, the population is listed such as Autism, Attention Deficit Hyperactivity Disorder (ADHD), PMS (Girls with Premenstrual Syndrome), etc.

Table 3. Domains of the studies.

Domain (Population/Measurement)	Count
Autism	8
Special Needs	5
Stress Reduction	3
ADHD	3

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Asthma	2
Well Being	2
Obesity	2
Self Concept	1
Hearing Loss	1
Domain (Population Or Measurement)	Count
Pulmonary Function	1
Pych & Immune	1
Attention	1
Coordination Disorder	1
Cervical Spondylopathy	1
Physiologic	1
Mental Health	1
At Risk	1
Cothymia	1
Domain (Population Or Measurement)	Count
Anxiety	1
Cerebral Palsy	1
Arthritis	1
Physiological	1
Fibromyalgia	1
Autonomic Nervous Sys	1
PMS	1
CardioVascular	1
Depression	1

Types of Studies, Sizes, and Interventions

Of the 45 studies most were Random Control Trials (29), though one of them used a random cluster for the groups rather than individualized random subjects. There were seven non-random control trials. There were nine non-random trials without a control, with most of them (8) using repeated measures.

The size of the trials ranged from 3 to 231, with the average of 54. The age ranged from 1 to 19. The types of interventions were split pretty evenly with 21 of the studies utilizing Qigong and 24 utilizing Tai Chi. The durations for the interventions ranged from 3 to 72, with an average of 14 and a median & mode of 12. Only two were a year or longer, however, so the median or mode would be a better measurement of central tendency than the mean.

There was also a large variety of dosage of the Tai Chi and Qigong sessions. As can be seen in Table 4, the most common session length was 60 minutes, and the most common frequency was 2 times per week. Therefore, most studies included more than

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an hour, some up to three hours per week. Only one study included six hours per week of

Table 4. Length and Frequency of Tai Chi and Qigong Sessions (Dosage) Tai Chi and Qigong.

Minutes	**Count**
80-90	(4)
60	(14)
40-50	(10)
20-30	(6)
15-18	(5)
5	(1)
Times per week	Count
7	(3)
5	(2)
3	(11)
2	(13)
1.5	(2)
1	(12)
Minutes per week	Count
300	(1)
150-180	(7)
105-135	(11)
80-90	(8)
60	(7)
40-50	(5)
10-30	(4)

It might be noted that the descriptive statistics of the studies themselves reveals a tendency that is not found in non-behavioral clinical trials. In a typical clinical trial on drugs or medical devices, there is a relatively narrow range for dosage; perhaps 5 or 6 different variations on amount and frequency of intervention. In these studies, as can be seen in Table 5, there is a huge variation. The standard deviation is twice the mean, and the kurtosis is leptokurtic, indicating an extreme number of outliers. This is an indication of the lack of consensus on how we should approach Tai Chi and Qigong, most specifically with children, in research studies. While this does represent the reality, this fact makes it extremely difficult for researchers to make conclusions about the preponderance of evidence. There are simply too many variables involved.

Additionally, typical phase 1 clinical trials are generally a few months long. For these studies on Tai Chi & Qigong, the length of these trials varied from 3 weeks to 52 weeks; a huge variation. Trying to aggregate or make conclusions about the

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entire set would be difficult given the variety of time frames.

Another issue that frequently arose is the idea that a double-blind study on Tai chi and Qigong can't be done. Most authors cited that the intervention "could not" be blinded. One study, however, did blind the intervention by not allowing contact between the subjects in the groups, and scheduling them at different times for the intervention so that they did not cross paths. They also did not specifically identify, to the subjects, what intervention they were using or what it was being compared to. This brings in another way to conduct a double-blind random control trial; eliminate the use of esoteric terms. Scholars have suggested that double-blind studies could be achieved by having the leaders describe the intervention in clinical terms of breath, movement, and intention [24] rather than calling it Tai Chi or Qigong or whatever. Controls can be similarly described, which would eliminate potential bias due to the labeling of the intervention. While understandably difficult because most Tai Chi and Qigong practitioners wouldn't know how to instruct in the activity without the esoteric language, it would be an informative activity to determine the possibility.

Table 5. Descriptive Statistics of Timeframe for Tai Chi and Qigong Studies of Children

Total Intervention Minutes of Tai chi and Qigong in Children	
Mean	1445.058
Standard Error	366.0543
Median	800
Mode	1800
Standard Deviation	2400.378
Sample Variance	5761817
Kurtosis	30.12437
Skewness	5.164187
Range	15560
Minimum	40
Maximum	15600
Sum	62137.5
Count	43

Controls and Outcomes

Another interesting finding from the 45 studies is the variety of controls that were utilized, as can be seen in Table 6. The 37 RCTs had nine different controls. The most common was Usual Activity (19) followed by Waitlist (6). There were others, including regular physical exercise (5) such

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as gymnastics, walking or aerobics. It should be noted that often the controls were deemed by the authors as "too similar" to the experimental intervention as a reason for lack of significance. It should also be noted that often the controls were not clearly described. In one case, the control was mentioned when discussing random allocation, and never mentioned again, without any description of what the control was, not even the ubiquitous "usual activity". For research purposes, even the term "usual activity" should be described. For these types of studies, it is extremely important to describe exactly what the subjects in the control group did instead of the intervention. For example, if the "usual activity" was gym class, that would be quite a different thing than if the "usual activity" was study hall. If the experimental group was "pulled out" of school to do the intervention, that in itself could bias the results because it might be the action of being pulled out of school for a time would have provided benefits regardless of the intervention.

There were 4 studies with more relaxing controls such as progressive muscle relaxation, arts and crafts, or watching a documentary on television. Four of the studies were actually testing a different intervention and were using either Qigong or Tai Chi as the control, and two used a sham Qigong intervention. Note that nine studies did not have controls, but five studies had more than one control group, which is why the total below shows 50 controls.

Table 6. Descriptions of Controls

Control Description	**Count**
Usual Activity	19
Waitlist	6
Physical Exercise	5
Other	
(Progressive Muscle Relaxation, Craft, Watch Documentary)	4
Tai Chi or Qigong	4
Sham Intervention	2
Unknown	1

The outcomes of the studies can be categorized as Psychological (20 studies), Physical (24 studies), or Behavioral (13 studies) with most studies including outcomes from more than one category. As can be seen from the extensive list in Table 7 showing all 122 outcomes from the 45 studies, there are no real standards when it comes to outcomes of Tai Chi and Qigong Studies. Most of these outcomes were only involved in a single study, and several (such

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as the Sense and Self-Regulation Checklist) was developed solely for the research of the primary investigator. Variety and lack of standards of this sort makes it very hard for researchers to aggregate data and do meta-analysis. Given the lack of study replication for confirmation purposes and the small sample sizes involved, even a large number of studies do not lend themselves to overall conclusions about Tai Chi and Qigong even if we were to ignore the variations in the treatments themselves. It does, however, speak to the wide range of potential benefits of Tai Chi and Qigong (for which we need a preponderance of evidence, of course, rather than a single study).

Table 7. List of all outcomes from Tai Chi and Qigong studies of children

Sense and Self-Regulation Checklist (SSC) (5)
Body Mass (BM) (4)
Salivary Cortisol (4)
Behavior Rating Inventory of Executive Function (BRIEF) (3)
Blood Pressure (BP) (3)
Heart Rate (3)
Skinfold thickness (3)
Autistic Behavior Checklist (ABC) (2)
Childhood Health Assessment Questionnaire (CHAQ) (2)
Habitual Activity Estimation Scale (HAES) (2)
Heart Rate Variability (HRV) (2)
Pediatric Asthma Quality Of Life Questionnaire (PAQOL) (2)
Pervasive Developmental Disorder Behavior Inventory (PDDBI) (2)
State-Trait Anxiety Inventory for Children (STAIC) (2)
Volume of Oxygen (VO2) (2)
Wingate Anaerobic Test (2)
6 Minute Walk Test
Academic Performance Ranking (APR)
Achenbach Teachers Report Form (TRF) of Autistic Behaviors
Allergen Sensitization
Asthma Sympton Score
Athletic Ability
Auditorial Stimulus Reaction Time
Autism Parenting Stress Index (APSI)

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Autism Treatment Evaluation Checklist (ATEC)
Beck Depression Inventory (BDI-II-C)
Berg Balance Scale
Body Fat (BF)
Body Weight
Bone Mineral Density (BMD) of the neck
Bunse Developmental Checklist (BDC)
Cardiorespiratory Fitness
Cardiovascular Fitness (CVF)
Cervical Curvature
Child Behavior CheckList (CBCL)
Childhood Asthma Control Test) C-Act
Childhood Depression Inventory (CDI)
Children's Color Trails Test (CCTT-T2)
Chinese Humor Scale (CHS)
Conners Teacher Rating Scale (CTRS)
Conners' Teacher Rating Scale 39 (CTR-39)
D2 Test of Attention
Delis-Kaplan Executive Function System (D-KEFS) Trail Making Test

Depression Anxiety and Stress Scale (DASS-C)
Developmental Neuropsychological Assessment (NEPPSY) Statue Task
Diagnostic and Statistical Manual of Mental Disorders (DSM-5)
Dietary intake
EEG during Go/No go task
EEG during memory recall task
Electromyography of trapezius muscle
Face Scale (FS)
Fall count
Fibromyalgia Impact Questionnair (FIQ)
Five Point Test (FPT)
Flexibility
Flow Cytometry Analysis of Treg Cells
Fractional Exhaled Nitric Oxide (FeNO)
Functional near-infrared spectroscopy (fNIRS)
Functional Reach Test (FRT)
Functional Status and Symptom Questionnaire (FSSQ)
General Stress

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Gilliam Autism Rating Scale 2 (GRASS-2)
Go/No Go Task
Grip Test
Habitual Physical Activity
Hopscotch Test
HR (response to orthostasis)
Lateral Gaze Assessment
Limits of Stability (LOS)
Lung function
Medicine Ball Push
Mindful Attention and Awareness Scale (MAAS)
Movement ABC (MABC-2)
Movement Assessment Battery for Children (MATC-2).
Multidimensional Assessment of Preschool Disruptive Behavior (MAP-DB)
Muscle Endurance (ME)
Muscle Fitness (MF)
Muscle Strength (1RM) Peak Muscle Power (W)
Neck Disability Index (ND1)

One Minute Pushup Test
One Minute Situp Test
Pain Visual Analog Scale (VAS)
Parenting Stress Index (PSI)
Patient Health Questionnaire Depression Scale (PHQ-9)
Peabody Gross Motor Scaled (PGMS)
Peak Force of Knee Extensors
Pediatric Quality of Life Inventory (PedsQL)
Perceived Stress Scale-Children (CPSS)
Perceived Stress Scale (PSS)
Peripheral Serum Cytokines (BDNF)
Peripheral Serum Cytokines (IL-10)
Peripheral Serum Cytokines (TNF-α)
Physical and Neurological Examination for Subtle Signs (PANESS)
Piers-Harris Children's Self-Concept Scale (PHCSCS)
Positive Psychological Capital Questionnaire (PPQ)
Pre-menstrual Syndrome Scale (PMS)
Psychological Distress Scale (PDS)
Pulmonary Function

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Pulmonary function test (PFT)
Pupil Rating Scale (PRS)
Qualitative - Changes in behavior & Whether to Continue
Quality of My Life (QOML)
Reaction Time
Rosenberg's Self-Esteem Scale (RSE)
Self-Image Test
Single-Leg Standing Test
Sit and Reach Test
Social Index
Standing Broad jump
Strengths and Weaknesses of ADHD Symptoms and Normal Behavior (SWAN)
Stress Scale (DASS)
Swanson Nolan and Pelham Rating Scale (DSNAP_HYP)
Thermograph of Hands
Tower of Londong Test - Drexel Version (TOLDX)
Turnover-Jars Test
Unipedal Stance
Vertical Jump test
Visual Analog Scales (VAS) of Quality of Life
Waste Circumference
Weiss Functional Impairment Rating Scale (WFIRS)
Well-Being at School (WBS)
Youth Self-Report (YSR)

The list of the 45 studies and which outcome measurements go with each can be found in the supplementary material accompanying this report or by contacting the corresponding author (Rhoads@kutztown.edu).

Systematic Review for Children with Neurodiversity

After the initial search narrowing the list to 45 studies, we narrowed the list further by including only those populations of children with neurodiversity. Neurodiversity is a complex relatively new domain of study with several subtypes, and we chose to include several subtypes. That netted ten studies, as can be seen in Table 8. Of the ten, six were neurodevelopmental disorders (autism [4 studies], development coordination disorder [1 study] and attention deficit/hyperactive disorder [1 study]. Four of the ten were mental health

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conditions (depression [2 studies], learning disabled [1 study] and anxiety [1 study])

The ten studies were pretty evenly split with Tai Chi (5) and Qigong (5), though some studies included the other as the control or had multiple experimental group. One enterprising study included four groups: Tai Chi in combination with muscle power training, muscle power training alone, Tai Chi alone, and the control group. In retrospect, it might have been more beneficial to limit the number of groups since the number of children in each group was quite small, limiting the potential power of the research. It is interesting to note, however, that only the Tai Chi alone group reported a significant difference, much to the surprise of the authors who expected that combining Tai Chi and muscle power training would be the superior outcome.

Developmental stage might be a mitigating factor in analyzing the results of our findings, and the age ranges can be found in Table 8. With one exception, the age ranges were consistently reported, but there did not appear to be any pattern regarding benefits for either younger or older children.

The outcomes and conclusions from each study is included in Table 9. The initial diagnostic tool used for screening, the reported quality of the instructor, and the level of description about the intervention is included in Table 10.

It can be seen from these tables that the duration of the interventions ranged from 1 to 3 months. It might be noted that all of the interventions lasting 2-3 months reported an overall benefit whereas only one study out of the two that lasted only 1 month reported benefit, and only one study out of the three that were 6 weeks long showed a benefit. While not conclusive and need more study, this would lend evidence to the fact that the duration of the intervention is highly correlated with positive benefit. None of the studies included a follow up to see if the benefits persisted after the study was over, or if the participants continued practicing Tai Chi after the study was over.

Table 8. Tai Chi and Qigong Studies on Children with Neurodiversity

Study#	Code and Reference	Year	Pop-Cond	Country	Size - Initial	Size - Final	Age Range	Mean Age	Intervention Description	TC or QG?	Duration	Session Length	Frequency	Standardized Control
04	04.Chan_2013_INREV3_QG-Autism [25]	2013	Autism	China	48	40	6-17		Nei Gong	QG	4 wk	60 min	2 x wk	PMR*
05	05.Chan_2015_INREV3_QG-Autism [26]	2015	Autism	China	66	48	5-17		Nei Gong	QG	4 wk	60 min	2 x wk	PMR, Usual Activity

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10	10.Fong_2022_TC-CoordinationDisorder [27]	2022	Development Coordination Disorder	China	121	88		9.73	Yang style and Strength Training	TC	12 wk	90 min	1 x wk	Usual Activity
18	18.Li_2024_QG-ADHD [28]	2024	Attention Deficit/ Hyperactive disorder	China	120	120	7-17	8.4	Baduan Jin (8 Brocades)	QG	12 wk	30 min	5 x wk	Physical Exercise
23	23.Min_2021_QG-MentalHealth [29]	2021	Depression	China	61	61	12-15		Mindfulness & QG	QG	6 wk	60 min	1-2 x wk	Usual Activity
26	26.Rodrigues_2021_QG-Anxiety [30]	2021	Anxiety	Portugal	104	104	13-18		Daoyin	QG	6 wk	17.5 min	1-2 x wk	Usual Activity, Other
28	28.Sarabzadeh_2019_TC-Autism [31]	2019	Autism	Iran	18	18	6-12	8.5	Yang 24	TC	6 wk	60 min	3 x wk	Usual Activity
36	36.Tabeshian_2022_TC-Autism [32]	2022	Autism	Iran	23	23	6-12	9.6	Yang Style	TC	12 wk	45 min	3 x wk	Unknown
45	45.Wang_2025_TC-SpecialNeeds [33]	2025	Learning Disabled	China	120	72	9-11	9.75	Tai Chi, Baduan Jin, Health Qigong	TC	12 wk	45 min	3 x wk	Usual Activity
49	49.Zhang_2018_INREV2_TC-Depression [34]	2018	Depression	China	64	64	16-19	18.4	Mindfulness based Tai Chi (Yang 24)	TC	8 wk	90 min	2 x wk	Usual Activity

Table 9. Outcomes and Conclusions from each study

Study Number	OriginalFileName	Overall positive benefit or not	Specific Outcomes	Effect size	Conclusion	Count of Outcomes in ROB 2	Count of Effect Sizes
04	04.Chan_2013_INREV3_QG-Autism.pdf	Y	Th autistic children in the experimental group showed better self-control than those in the control group after the one month intervention. The mean reduction of the experimental group (-8.53) was about four times that of the control group (-2.82). The experimental group became less impulsive in problem-solving. Reduced completion time, Improved Sociability, Improved Sensory/Cognitive	Rule Violation 0.92 Initial Time 0.86 CCTT 0.83 FPT 0.8 Health/Physical/Behavior 0.66 Sensory/Cognitive Awareness 0.49 Sociability 0.68 Speech/Language/ Communication 0.29 Elevated ACC activity 0.10	This study provides evidence that one month of training in Chinese Chan-based mind-body exercise *Nei Yang Gong* had a positive effect in enhancing self-control of children with ASD. This cognitive enhancement coincided with significantly elevated brain activity in the anterior cingulate cortex. This encouraging finding confirms the	5	9

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			Awareness, Improved Health/Physical Behavior, Decreased Temper Outbursts, Decreased Obsessive Behaviors. Also Significant elevated activity in the rostral ACC region of the brain during the No-go condition indicating treatment-induced level of hypoactivity as compared to normal children. [Note from Review Authors: The anterior cingulate cortex (ACC) is a documented generator of theta oscillations (4–8 Hz) in the brain, and this activity is critical for cognitive functions such as conflict monitoring, error processing, and memory.]		potential clinical applicability of this Chinese mind-body exercise in enhancing the self-control of individuals with various brain disorders.		
05	05.Chan_2015_INREV3_QG-Autism.pdf	Y	The results of the post hoc paired t-test suggested that the significant interaction effect resulted from the significant imporvement in those measure in children who received NGT. Overall, regular practice of Nie Gong for 1 month helped enhance memory recall and memory retrieval strategies.	Improvement in randomized condition, total recall, and visual scanning in the organized condition effect size ranges from .57 to .73 (Enhanced memory recall and memory retrieval strategies) 0.65	The present study has revealed potential effects of a Chinese mind-body exercise, Nei Gong, on facilitating more flexible and effective use of strategies to aid memory in children with ASD. The children with ASD demonstrated the application of a more efficient neural network for memory processing after the practice of Nei Gong. These encouraging findings have provided insight into the clinical	1	1

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					applicability of Nei Gong as a possible neurocognitive enhancement approach for individuals with ASD.		
10	10.Fong_2022_TC-Coordination Disorder.pdf	Y	In LOS and DLOS: There were no significant between-group differences at any time points. An improvement in the peak force of the knee extensors with time was seen exclusively in the TC group. Only the MPT group showed an improvement in the peak force of the knee flexors. The MABC-2 were relatively stable for all groups. No group, time, or group-by-time interaction effects were noted. The total number of falls decreased significantly in both the TC and and MTP groups, but not the combined TC-MTP group.	Falls After 3 months 2.77 Falls After 12 months 1.14 Completion Time 1.23 Dynamic 0.93 Total Test Score 0.45 Rank 1.03 Extensor 0.76 Flexor 0.85 Time of Extensor 0.25 Time to Flexor 0.06	TC training strengthened the knee extensor muscles and the MPT strengthened the knee flexor muscles of children with DCD. Either TC or MPT alone decreased the number of falls. However, combining TC and MPT did not improve lower limb muscular performance, motor performance, or the LOS and balance control, or decrease the number of falls in these children. Thus, clinicians may suggest TC or MPT as stand-alone interventions to children with DCD.	3	10
18	18.Li_2024_QG-ADHD.pdf	N	The mean difference between the two groups were not significant in any of the prespecified subgroups except for the no ADHD-related medical usage subgroup)1.94; p=.04). A consistent trend of reduction from baseline occurred in the DSNAP_INA, DSNAP_ODD, PSNAO_INA, PSNAP_HYP,	Yes to medical usage 0.17 No to medical usage 0.04 Inattention doctor assessed 0.02 Hyperactivity/Impulsivity doctor assessed 0.33 Oppositional/Defiance doctor assessed 0.19 Inattention parent assessed 0.11 Hyperactivity/Impulsivity parent assessed 0.05	The present trial does not establish a significant superiority of Baduanjin exercise of routine physical exercise in treating ADHD in children. However, our findings offer valuable insights. After 3 months of consistent exercises, both demonstrate considerable improvement in core ADHD symptoms	4	11

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			PSNAP_ODD, TCM, and all the subscores in the GRIEF-2 scale including inhibition, self-monitor, shift, emotional control, initiate, working memory, plan/organize, and task monitor. In WFIRS, only the Baduanjin exercise group showed slight reductions in all subscores at both the third and sixth month.	Oppositional/Defiance parent assessed 0.04 Traditional Chinese Medicine Symptoms 0.22 Inhibition, Emotional Control, Initiation, Working memory and Plan/Organize (only differences in subscale reported, no means) Functional Impairment: Family, School, Life skills, Self-concept, Social activities, Risk (only differences in subscale reported, no means)	and executive functions. In light of these results, we proposal the necessity to advocate either type of exercies as non-pharmaceutical therapy option for children with ADHD.		
23	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64.pdf	Y	There was no significant difference in the score between the Experimental group and the control group before and after intervention. [Both were lower]. After the intervention, the anxiety score in the Experimental group was significantly lower than that in the control group. The scores regarding optimism, hope, self-efficacy, and psychological capital in the Experimental group were increased, significantly higher than before the intervention and significantly higher than that of the control group. There	Depression Scores 2.69 Anxiety Scores 4.94 Psychological Capital 4.50 Optimism 3.48 Hope 4.23 Self-efficacy 3.61 Resiliency 0.45	In this study, a comprehensive intervention method integrating positive rumination counseling with health Qigong exercises was used for the intervention of teenagers' depression, anxiety, and other psychological problems. The research findings show that the intervention pattern can effectively lower teenagers' anxiety level, enhance the levels of optimism, hope, self-efficacy, psychological capital; indicating that this method can	3	7

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			was no difference in the resiliency score, nor was it different from the control group.		cultivate teenagers' positive psychology and weaken negative psychology.		
26	26.Rodrigues_2021_QG-Anxiety.pdf	Y	The overall state anxiety (STAI Y1) revealed no significant differences between groups at any timepoint. The QG group was the only group with constantly decreasing tendency for its mean during the study. For the QG group, a statistically significant reduction in state anxiety occurred between the midpoint and post intervention as well as between baseline and postintervention. The Greenhouse-Geisser test allowed the conclusion that about 25% of the variance during the intervention was due to the Qigong practice. The overall trait anxiety (STAI Y2) revealed no significant differences between groups for overall trait anxiety at any time point. The QG group showed the only significant difference in trait anxiety, a 7.27% improvement, between baseline and postintervention. The three groups showed a drop in	STAI Y-1: Current Anxiety 0.44 STAI Y-2: General Anxiety 0.23 Salivary Cortisol 0.17	In the current study, Qigong practice seemed to product significant positive changes in state and trait anxiety for students in the short term. The psychological and biochemical assessments and results shown in the current study strengthen the idea that Qigong may be an efficient tool to reduce anxiety and control stress at school.	2	3

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			cortisol levels, but none of the groups presented statistically significant differences. The drop in cortisol in QG group showed an improvement of 16.7%.				
28	28.Sarabzadeh_2019_TC-Autism.pdf	Y	A noticeable difference was observed between pre-test and post-test scores of ball skills and balance variables in the experimental group whereas no difference was reported beween pre & post-test in the control group. In regards to manual dexterity, no difference was seen. The results showed improved motor skills in children with ASD under the influence of sixe weeks of Tai Chi Chuan training. The training program appears to improve balance and ball skills, whereas it does not appear to be a useful method to positively affect manual dexterity in autistic children.	Total MABC-2 Motor Skill Score 3.52	Tai Chi Chuan training program may improve hand-foot coordination, muscular tone, sensory homogeneity, body awareness, and particularly self-confidence in autistic children. In sum, it can be confidently recommended to all relevant coaches and therapists to consider Tai Chi Chuan forms as a primary choice for rehabilitation programs in children with ASD.	1	1
36	36.Tabeshian_2022_TC-Autism.pdf	Y	Stereotypic behavior was reduced as a result of Tai Chi Chuan training. There was significant difference between Tai Chi Chuan and control groups at post-test whilst controlling pre-test scores.	Stereotypic Autistic Behavior 0.45	Mild martial arts mindful action such as contained in Tai Chi Chuan training can reduce stereotypic behavior of children with autism spectrum disorder.	1	1

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45	45.Wang_2025_TC-SpecialNeeds.pdf	Y	Significant differences were also observed in Academic Performance Ranking scores amont the groups. Post hoc analysis indicates that all three intervention groups had higher APR scores compared to the control group. For inhibition scores, significant differences were found b etween the groups. Post hoc comparisons showed that the TC group had significantly lower scores compared to the BD group and the control group. (Lower scores means an improvement). Finally, the Working Memory scores showed significant difference among the groups. Post hoc comparisons indicated that the TC group had significantly lower scores compared to the BD group, YJJ group, and control. (Lower scores means an improvement). Additionally, significant group differences in effective connectivity changes were found. Post hoc comparisons revealed that the TC group exhibited significantly higher effective connectivity.	Pupil Rating Scale (All treatment groups aggregated) 1.17 Academic Performance Ranking (All treatment groups aggregated) 0.61 Inhibition 0.38 Shifting 0.13 Emotional Control 0.27 Initiation 1.57 Working Memory 1.02 Planning 0.00 Organization 0.32 Monitoring 0.59 Functional near-infrared spectroscopy (not reported)	This study demonstrates that traditional Chinese mind-body exercises such as Tai Chi, Baduanjin, Yijinjing have a significant positive impact on academic performance and executive function in children with learning difficulties. These findings suggest that incorporating these exercises into educational programs may enhance not only cognitive abilities, but also emotional regulation, resilience, and stress management.	4	11

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49	49.Zhang_2018_INREV2_TC-Depression.pdf	Y	The results found a significant interaction between time and condition for PHQ-9, MAAS, and CPSS. Furthermore, simple effect analysis were used to figure out how the time and group interaction effects were different. The categorical outcomes for the PHQ-9 scale show that after the intervention, the rates of Subthreshold Depression and major depression in the MTCC group were lower than those of the control group.	Patient Health Questionnaire Depression Scale Time Effect 1.00 Perceived Stress Scale Time Effect 0.70 Mindful Attention and Awareness Scale Time Effect 0.94 Patient Health Questionnaire Depression Scale 2.63 Perceived Stress Scale 3.03 Mindful Attention and Awareness Scale 5.69 No Depression 1.37 Subthreshold Depression 1.25	Results from this RCT showed that MTCC is effective in reducing depression symptom levels in StD adolscents. StD is a psychological condition between health and depression, and if no timely and effective intervention is done, it is more likely to develop to major depressions. Mindful Tai Chi Chuan is a feasible, easily disseminated intervention that may help reduce the population disease burden of depression.	3	8
10	Count of studies				Count of Outcomes and Effect Sizes:	27	62

Table 10. Diagnostic Tool, Quality of Instructor, Intervention description

Study#	Code and Reference	Diagnostic Tool for Neurodiversity	Quality of Instructor reported	Intervention Description	Level of description of intervention
04	04.Chan_2013_INREV3_QG-Autism [25]	DSM-IV-TR	Not reported	Nei Gong	External reference to description
05	05.Chan_2015_INREV3_QG-Autism [26]	DSM-IV-TR	Not reported	Nei Gong	External reference to description
10	10.Fong_2022_TC-CoordinationDisorder [27]	Not reported	Not reported	Yang style and Strength Training	Not reported
18	18.Li_2024_QG-ADHD [28]	SNAP-IV	Reported - Yes	Baduan Jin (8 Brocades)	Specific movements described. Not live intervention - using Kinect on Xbox with game-like video.
23	23.Min_2021_QG-MentalHealth [29]	BDI-II-C	Not reported	Mindfulness & QG	Minimal description
26	26.Rodrigues_2021_QG-Anxiety [30]	None used	Reported - Yes	Daoyin	External reference described
28	28.Sarabzadeh_2019_TC-Autism [31]	GARS2	Reported - Yes	Yang 24	Minimal description
36	36.Tabeshian_2022_TC-Autism [32]	Not reported	Reported - Yes	Yang Style	Specific movements described.
45	45.Wang_2025_TC-SpecialNeeds [33]	PRS	Reported-Yes	Tai Chi, Baduan Jin, Health Qigong	Specific movements described.
49	49.Zhang_2018_INREV2_TC-Depression [34]	PHQ-9	Reported -Y	Mindfulness based Tai Chi (Yang 24)	Minimal description

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Risk of Bias Evaluation Results

The Risk of Bias was assessed using ROB 2. The largest difference between ROB 2 and ROB 1 is that ROB 1 assessed the entire study as a whole, while ROB 2 assessed each individual outcome or result. Additionally, while ROB 1 included information on whether a study reported results using *intention to treat* or *per protocol* basis, that assessment is central to the ROB 2, separating out the results based upon that concept.

While an initial attempt was made to utilize the official ROB 2 tool (which was an Excel-based application utilizing macros), it was determined that the tool was adding a lot of time-consuming logistical challenges, which confirmed the findings of previous investigators [35]. Two of the logistical challenges (which did not appear to have a material impact on the actual assessment of bias) was that the tool is designed in such a way that every value for every outcome for every study has to be typed in. It appeared that one could not, for example, copy and paste from an already-prepared spreadsheet to the ROB 2 tool. Even when assessing two different outcomes for the same study, for example, all the study demographics had to be re-entered, duplicating effort. Crocker et al found that it took almost six hours to do the data entry on each study, possibly due to this sort of duplication. Since the data for these studies had already been extracted and only the risk of bias needed to be assessed, the duplicate effort was an ineffective use of time. Additionally, several technical issues resulted in errors and missing information in the final reports as published directly in the tool when one author attempted to use it. Therefore, the spreadsheet fields were duplicated in a new spreadsheet and each outcome was assessed and entered following the guidelines, but not necessarily utilizing the tool. This allowed for copy and paste as appropriate, providing the underlying detail as well as the summary figures and assessments.

Although we only found 10 articles to evaluate based on the criteria, those 10 articles ranged from 1 to 11 outcomes. ROB 2 guidance notes that it may be appropriate to include only some of the outcome as "results of interest" for ROB 2 review, so the authors grouped the outcomes/results where possible for the ROB 2 assessment. That resulted in 31 ROB 2 assessments for the 10 studies.

As noted, evaluating each outcome separately rather than evaluating the study as a whole was one of the differences between ROB 1 and ROB 2. The other difference was the focus on *assignment to*

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intervention (the 'intention-to-treat' effect) versus *adhering to intervention (the 'per-protocol' effect).*

As can be seen in the Table 11, these are listed separately. Only two studies reported the assignment-to-intervention, which means that they included data for the subjects who dropped out of the study, utilizing one of several possible analytical calculations to estimate the values for those subjects. This eliminates the possibility that bias was introduced into the study because the subjects who withdrew might have withdrawn for some reason related to the intervention. While most studies reported the reason that subjects who started the study didn't finish, sometimes just reporting the reason would not be enough to eliminate the potential bias, hence the focus in the ROB 2 assessment. We reported intention-to-treat only when the authors specifically noted intention-to-treat, which was only in two studies. These two differences (intention-to-treat versus per-protocol) was not always discussed by the authors. When the data reported on a different number n than initially discussed, it was clear that the per-protocol was utilized. But when the number of subjects initially discussed equaled the number of subjects for which data was reported, the authors may have been using an intention-to-treat, but no one withdrew from the study so they had 100% of the data for each subject even if they were using a per-protocol. To err on the side of caution, and because "no information" was not an option provided by the ROB 2 tool, we chose per-protocol.

Preliminary results are that the overall Risk of Bias for most studies was low as none of the studies had a high risk of bias for more than 1 of the categories. The areas of concern for two of the studies was in reporting of the data as only effect size differences were reported and not the actual means or standard deviations. Four of the studies did not blind the assessors, and only one of the studies blinded the participants. Overall, the authors judged the quality of the studies as generally high.

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Table 11. Risk of Bias 2 Results on 10 studies (31 outcomes)

Unique ID	Study ID	Experimental	Comparator	Outcome	Weight	D1	D2	D3	D4	D5	Overall
Intention-to-treat											
13	18.Li_2024_QG-ADHD	QG-Baduan Jin (8 Brocades)	Physical Exercise	Medical Usage	120	+	+	+	+	-	
14	18.Li_2024_QG-ADHD	QG-Baduan Jin (8 Brocades)	Physical Exercise	Swanson, Nolan and Pelham Rating Scale (DSNAP_HYP)	120	+	+	+	+	-	
15	18.Li_2024_QG-ADHD	QG-Baduan Jin (8 Brocades)	Physical Exercise	Traditional Chinese Medicine Symptoms	120	+	+	+	+	-	
16	18.Li_2024_QG-ADHD	QG-Baduan Jin (8 Brocades)	Physical Exercise	Behavior Rating Inventory of Executive Functin (BRIEF)	120	+	+	+	+	-	
17	18.Li_2024_QG-ADHD	QG-Baduan Jin (8 Brocades)	Physical Exercise	Weiss Functional Impairment Rating Scale (WFIRS)	120	+	+	+	+	-	
23	28.Sarabzadeh_2019_TC-Autism	TC-Yang 24	Usual Activity	Movement ABC (MABC-2)	18	+	+	+	!	+	
Per-protocol											
1	04.Chan_2013_INREV3_QG-Autism	QG-Nei Gong	Progressive Muscle Relaxation	Tower of London Test - Drexel Version (TOLDX) Rule Violation	40	+	+	+	+	+	+
2	04.Chan_2013_INREV3_QG-Autism	QG-Nei Gong	Progressive Muscle Relaxation	Tower of London Test - Drexel Version (TOLDX) Initial Time	40	+	+	+	+	+	+
3	04.Chan_2013_INREV3_QG-Autism	QG-Nei Gong	Progressive Muscle Relaxation	Children's Color Trails Test (CCTT-T2)	40	+	+	+	+	+	+
4	04.Chan_2013_INREV3_QG-Autism	QG-Nei Gong	Progressive Muscle Relaxation	Five Point Test (FPT)	40	+	+	+	+	+	+
5	04.Chan_2013_INREV3_QG-Autism	QG-Nei Gong	Progressive Muscle Relaxation	Autism Treatment Evaluation Checklist (ATEC)	40	+	+	+	+	+	+
6	04.Chan_2013_INREV3_QG-Autism	QG-Nei Gong	Usual Activity	EEG during Go/No go task	40	+	+	+	+	+	+
7	05.Chan_2015_INREV3_QG-Autism	QG-Nei Gong	Usual Activity	EEG during memory recall task	48	+	+	+	+	+	+
8	05.Chan_2015_INREV3_QG-Autism	QG-Nei Gong	Progressive Muscle Relaxation	Memory Function Measures: Semantic Clustering, Visual Scanning, and Total Recall	48	+	+	+	+	+	+
9	10.Fong_2022_TC-CoordinationDisorder	TC-Yang style and Strength Training	Usual Activity	Fall count	NA	+	+	+	+	+	+
10	10.Fong_2022_TC-CoordinationDisorder	TC-Yang style and Strength Training	Usual Activity	Limits of Stability (LOS)	NA	+	+	+	+	+	+
11	10.Fong_2022_TC-CoordinationDisorder	TC-Yang style and Strength Training	Usual Activity	Movement Assessment Battery for Children (MATC-2)	121	+	+	+	+	-	
12	10.Fong_2022_TC-CoordinationDisorder	TC-Yang style and Strength Training	Usual Activity	Peak Force of Knee Extensors	121	+	+	+	+	-	
18	23.Min_2021_QG-MentalHealth_dnb_vol34_n21_64	QG-Qigong & Mindfulness	Usual Activity	Beck Depression Inventory (BDI-II-C)	NA	+	+	+	!	+	
19	23.Min_2021_QG-MentalHealth_dnb_vol34_n21_64	QG-Qigong & Mindfulness	Usual Activity	Diagnostic and Statistical Manual of Mental Disorders (DSM-5)	NA	+	+	+	!	+	
20	23.Min_2021_QG-MentalHealth_dnb_vol34_n21_64	QG-Qigong & Mindfulness	Usual Activity	Positive Psychological Capital Questionnaire (PPQ)	NA	+	+	+	!	+	
21	26.Rodrigues_2021_QG-Anxiety	QG-Daoyin	Usual Activity	State-Trait Anxiety Inventory for Children (STAIC)	NA	+	+	+	!	+	
22	26.Rodrigues_2021_QG-Anxiety	QG-Daoyin	Usual Activity	Salvary Cortisol	NA	+	+	+	!	+	
24	36.Tabeshian_2022_TC-Autism	TC-Yang	Unknown	Gilliam Autism Rating Scale 2 (GRASS-2)	NA	+	+	+	!	+	
25	45.Wang_2025_TC-SpecialNeeds	TC&QG-Baduan Jin	Usual Activity	Academic Performance Ranking (APR)	NA	+	+	+	!	+	
26	45.Wang_2025_TC-SpecialNeeds	TC&QG-Baduan Jin	Usual Activity	Pupil Rating Scale (PRS)	NA	+	+	+	!	+	
27	45.Wang_2025_TC-SpecialNeeds	TC&QG-Baduan Jin	Usual Activity	Behavior Rating Inventory of Executive Functin (BRIEF)	NA	+	+	+	!	+	
28	45.Wang_2025_TC-SpecialNeeds	TC&QG-Baduan Jin	Usual Activity	Functional near-infrared spectroscopy (fNIRS)	NA	+	+	+	!	+	
29	49.Zhang_2018_INREV2_TC-Depression	TC-Yang 24	Usual Activity	Patient Health Questionnaire Depression Scale (PHQ-9)	NA	+	+	+	+	+	+
30	49.Zhang_2018_INREV2_TC-Depression	TC-Yang 24	Usual Activity	Perceived Stress Scale (CPSS)	NA	+	+	+	+	+	+
31	49.Zhang_2018_INREV2_TC-Depression	TC-Yang 24	Usual Activity	Mindful Attention and Awareness Scale (MAAS)	NA	+	+	+	+	+	+

+ Low risk
! Some concerns
- High risk

D1 Randomisation process
D2 Deviations from the intended interventions
D3 Missing outcome data
D4 Measurement of the outcome
D5 Selection of the reported result

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Effect Size calculations

In order to attempt some standardization of impact among the different measurements, we attempted to calculate effect sizes on each one. The 31 different outcomes actually resulted in 59 different results for which effect sizes could be calculated, and three results for which effect sizes could not be calculated (because the authors did not report enough information to calculate an effect size) for a total of 62 outcome results from 10 studies. To explain why this is true, one outcome might have multiple results if the measurement was done more than once (at 3 months and 6 months, for example), or if the authors reported submeasurements (such as Sociability, Health, Physical, Behavior, Sensory Cognitive Awareness, Communication, or Speech/Language subscores of the Autism Treatment Evaluation Checklist). While these were groups for the ROB 2 assessment, they could not be grouped when calculating the effect size.

Many authors simply provided effect sizes (usually Cohen's d), and in those cases we simply reported the number they reported. Most of the time, those effect sizes were reported on the difference between the intervention and the control. In other cases, we calculated the effect size based upon whatever information was provided. Because different information was reported, we utilized four different methods for calculating effect sizes depending upon which information was given in the articles, listed in Table 12. Which calculation was used (or if the effect size was simply reported directly) is listed in the fourth column of the table (Table 13). Sometimes the effect size calculated was the impact of the intervention, not the difference between the intervention and the control. This information was listed in the sixth column of the table of Effect Sizes.

Table 12. Effect Size Statistics calculation information

Name of statistic	Description of calculation	Excel version of calculation
Cohen's d	As reported by author	
Cohen's d from mean	Mean difference/($\sqrt{((SD_1^2 + SD_2^2) / 2)}$)	=(M1 - M2)/ (SQRT((SD₁² + SD₂²) / 2))
Cohen's h from proportion	2 * (arcsin(sqrt(p1)) - arcsin(sqrt(p2)))	=2 * (ASIN(SQRT(D40)) - ASIN(SQRT(F40)))
Cohen's d from t value	$(t \times \sqrt{((1/n_1) + (1/n_2))})$.	=(t *SQRT((1/ n₁)+(1/ n₂)))
Cohen's d from confidence interval	=(M1 - M2)/ (pooled SD from CI (Square Root(N) * (upper-lower)/ (t*2))	=(M1 - M2)/ (SQRT(((CI_width₁/2) * (√n₁)/CriticalValue₁+ (CI_width₂/2) * (√n₁) / CriticalValue₂)/2))

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Please note that all effect sizes were converted to positive numbers if the negative "effect" was a positive one. For example, if the measurement was medical usage, and a lower number for medical usage was a good thing, then the absolute value of the effect size was reported instead of the negative number (in this case .04 instead of -.04). It should be noted that there were no outcomes with negative impacts reported for any of the Tai Chi and Qigong interventions (though occasionally there was a negative impact of a control group).

Of the studies with effect sizes, 41 of them (69.4%) were significant at the .05 alpha level. More importantly from a practical perspective, the mean effect size when compared to controls is 1.01 with a confidence interval (CL of 95%) of -.67 to 1.35, which means the average intervention has a large effect. When calculating the effect size only on the difference (which mean the effect size only compared the pre-tests with the post-tests), the effect size is even larger. The mean effect size is 1.71, with a confidence interval (CL of 95%) of 1.09 - 2.33. The bottom line: an overall conclusion can be drawn that Tai Chi and Qigong interventions have a large impact on the subjects.

Comparison to Previous Systematic Review Findings

In general, the findings of previous systematic reviews that included some of the studies in this paper are very similar. Sixteen of the original 45 studies had been previously included in systematic reviews, but only three of our ten studies were reviewed in other reviews. The quality of fifteen of the original 45 studies were reviewed [36] using the Critical Appraisal Skills Programme (CASP) rather than assessing the amount of risk which is the focus of the ROB 2 that we utilized. Overall Riskowski and Almeheywawi found that six were high quality and nine were low quality using the cutoff of 80% of the CASP criteria were found to be acceptable. The three out of our ten were not included in that systematic review. Only the Zhang study was included in a systematic review that assessed quality, and was found to be high quality [37]. The other two studies found elsewhere were in literature reviews without a quality assessment.

One would have thought that a 2019 systematic review of Qigong in the treatment of autism would have quite a few of our studies, but it did not. The primary reason was that the 2019 systematic review only found seven studies, and all seven

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were authored by Silva, who dominated the literature of Qigong from 2007 to 2016 by developing and researching a sensory Qigong-based massage for infants and young children that was done by their parents, caregivers, or practitioners. Since we specifically excluded non-self massage Qigong, none of those studies were included in our list. While this sensory massage was quite successful in making an impact on the lives of the children, it was not close enough to the movement-based interventions included in our study.

Overall Discussion of Study Findings

Of the ten studies included in our systematic review, nine reported an overall positive benefit. The sole study that did not report a positive benefit compared Qigong with regular exercise for children with ADHD [38]. It should be noted that neither group was led by an instructor; the Qigong subjects were simply asked to watch the Qigong video and perform it for 30 minutes a day for six months. The exercise group was told to do any type of exercise for 30 minutes a day. Additionally, there was a marked benefit - for both groups. There was only 1 significantly different result in that the Qigong group needed less medication after the intervention than the exercise group.

All nine of the other studies included significant benefits over the control group. Chan, et al, used both parent assessment and EEG activity as a biomarker to see if Nei Yang Gong made an impact on Autistic children. There was a significant difference from the group utilizing progressive relaxation for self-control, which was accompanied by significant difference on the brain activity in the anterior cingulate cortex of the children doing Nei Yang Gong [25]. Chan, et al, replicated the protocol for another study with a different set of children for a different outcome (effective use of memory strategies in autistic children), and found a significant different with the children who practiced Nei Gong utilizing a more efficient neural network for memory processing [26]. Sarabzadeh, et al, also worked with autistic children, and found Tai Chi Chuan improved hand-foot coordination, muscular tone, sensory homogeneity, body awareness, and self-confidence [31]. Tabeshian, et al, found that stereotypic autistic behavior decreased by 25% after three months of Tai Chi Chuan [32].

Fong, et al, reported that Tai Chi combined with Muscle Power Training did not have any effect on lower limb muscular

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performance, motor performance, or the Limit of Stability and balance control of children with developmental coordination disorder. Neither did the combined exercise decrease the number of falls in the children. This was surprising to them, as the authors had hypothesized that combining Tai Chi with Muscle Power Training would significantly improve its impact. Instead, they found that Tai Chi training alone strengthened the knee extensor muscles. The Muscle Power Training alone strengthened the knee flexor muscles. Either individually (but not when combined) decreased the number of falls [27].

Min and Yao used a method they called "rumination group counseling" along with Qigong exercises which had a significant positive effect on teenagers with depression, anxiety, and other neurodiverse problems. The combination effectively lowered the subject's anxiety levels and raised their levels of optimism, hope, self-efficacy, and psychological capital [29]. Rodrigues, et al, also found Qigong made a significant difference in lowering anxiety levels in children and helping them to control stress at school. This impacted both the "state" [short term conditions] and "trait" [long term personality] aspects of the children [30]. Zhang, et al, found significant improvement in levels of depression among adolescents after an eight-week Mindfulness-based Tai Chi Chuan using the Yang form [34]

Wang and Li directly tested the impact of Tai Chi versus two different types of Qigong (Bajuanjin and Yijinjing) in a controlled study with 72 children. All three groups showed improvement over the control group in academic performance ranking and pupil rating scale as well as executive function. In the three groups, the Tai Chi group showed superior improvements in executive function and pupil rating scores. The Tai Chi group also showed enhanced effective connectivity from the left and right dorsolateral prefrontal cortex to Brodmann area 8 in the brain, which indicated improved brain communication [33].

All of the studies had relatively small group sizes, ranging from 18 to 120. They were also of short duration, ranging from 1 month to 3 months. Rodriguez, et al, specifically noted that six weeks of intervention were required to show results for the Qigong group, though Chan found an impact in only four weeks.

While all of the authors noted that the instructor was experienced with children of the specific modality of the study, only

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Fong, et al; Wang & Li;, Rodrigues, et al; Sarabzadeh, et al, and Zhang, et al specifically mentioned the experience the instructors had with the Tai Chi or Qigong intervention. This is important because it might be the case that a short-term training of Tai Chi or Qigong might not be sufficient to ensure mastery of the specifics of the arts. The descriptions given in the studies were often simply a list of posture names, without any mention of the full range of movement/breath/intention/weight shift that are critical to the essence of the art. Some of the highest quality studies of Tai Chi and Qigong for adults provide much more detailed descriptions of the intervention such as Yang, et al, study on Tai Chi and Qigong on Influenza [39].

There was also a wide range of duration of the sessions, ranging from 17 to 90 minutes. This is difficult to assess, however. While 17 minutes may seem very short, 90 minutes might be too long for children.

Most authors mentioned that there were no adverse outcomes reported.

Limitations

While the information aggregated in this systematic review is important and furthers the current state of research on Tai Chi and Qigong and children with neurodiversity, there are many limitations to this study. The "Search Everywhere" tools provided by Ebsco are AI based and are not fully tested. While it is obvious that many more studies from a much larger variety of sources were found than had been found in the past, because some of those sources are not as well known they must be reviewed with caution.

Because neurodiversity itself is a relatively new field with ever-changing definitions, the authors had many long discussions on exactly what should be left in, and what should be left out. That, in itself, may have introduced a certain bias that might have influenced the systematic review.

Similarly, the lack of consensus in the literature of the spelling and use of Tai Chi and Qigong and the differences thereof may have also influenced the conclusions of the systematic review. Several of the authors have extensive experience in Tai Chi and Qigong, but there was much discussion on exactly what constituted which. These discussions ended up in agreement, but the varied backgrounds of the authors may still have impacted the conclusions.

Reporting on the initial set of 46 reports without being able to make conclusions on them is also a potential issue. As noted in the main paper, the variety of interventions, durations, frequencies, and outcomes

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makes the conclusions subject to the need for follow-up reviews.

Conclusion

The conclusion is there are more studies on TC&Q and children than we had realized. TC&Q studies of children with neurodiversity are relatively high quality. Furthermore, TC&Q interventions have a large impact on children with neurodiversity. These impacts are equal, or superior, to other types of interventions.

Despite the variety of interventions, durations, frequencies, and outcomes, it can be safely concluded that in most cases there is a preponderance of evidence that children with neurodiversity may benefit from Tai Chi and Qigong practices on all three aspects; physical, psychological, and behavioral. Of course, further research needs to be done with more standardized interventions, durations, frequencies and outcomes to be able to ensure a more solid weight of evidence.

Table 13. Effect Sizes

	Studies and Outcomes	Suboutcome	Effect Size	Which formula or reported	Compared to Control?	Significan
1	04.Chan_2013_INREV3_QG-Autism:Tower of London Test - Drexel Version (TOLDX)	Rule Violation	0.92	Reported	Y	Y
2	04.Chan_2013_INREV3_QG-Autism:Tower of London Test - Drexel Version (TOLDX)	Initial Time	0.86	Reported	Y	Y
3	04.Chan_2013_INREV3_QG-Autism:Children's Color Trails Test (CCTT-T2)	CCTT	0.83	Reported	Y	Y
4	04.Chan_2013_INREV3_QG-Autism:Five Point Test (FPT)	FPT	0.8	Reported	Y	Y
5	04.Chan_2013_INREV3_QG-Autism:Autism Treatment Evaluation Checklist (ATEC)	Health/Physical/Behavior	0.66	Reported	Y	Y
6	04.Chan_2013_INREV3_QG-Autism:Autism Treatment Evaluation Checklist (ATEC)	Sensory/Cognitive Awareness	0.49	Reported	Y	Y
7	04.Chan_2013_INREV3_QG-Autism:Autism Treatment Evaluation Checklist (ATEC)	Sociability	0.68	Reported	Y	Y
8	04.Chan_2013_INREV3_QG-Autism:Autism Treatment Evaluation Checklist (ATEC)	Speech/Language/Communication	0.29	Reported	Y	N
9	04.Chan_2013_INREV3_QG-Autism:EEG during Go/No go task	Elevated ACC activity	0.10	Cohen's d from t value	Y	Y
10	05.Chan_2015_INREV3_QG-Autism:EEG during memory recall task	Improvement in randomized condition, to	0.65	Averaged from Reported Range	Y	Y
11	10.Fong_2022_TC-CoordinationDisorder:Fall count	After 3 months	2.77	Reported	Y	Y
12	10.Fong_2022_TC-CoordinationDisorder:Fall count	After 12 months	1.14	Reported	Y	Y
13	10.Fong_2022_TC-CoordinationDisorder:Limits of Stability (LOS)	Completion Time	1.23	Reported	Y	Y
14	10.Fong_2022_TC-CoordinationDisorder:Limits of Stability (LOS)	Dynamic	0.93	Reported	Y	Y
15	10.Fong_2022_TC-CoordinationDisorder:Movement Assessment Battery for Children (MATC-2)	Total Test Score	0.45	Reported	Y	N
16	10.Fong_2022_TC-CoordinationDisorder:Movement Assessment Battery for Children (MATC-2)	Rank	1.03	Reported	Y	Y
17	10.Fong_2022_TC-CoordinationDisorder:Peak Force of Knee	Extensor	0.76	Reported	Y	Y
18	10.Fong_2022_TC-CoordinationDisorder:Peak Force of Knee	Flexor	0.85	Reported	Y	Y
19	10.Fong_2022_TC-CoordinationDisorder:Peak Force of Knee	Time of Extensor	0.25	Reported	Y	N
20	10.Fong_2022_TC-CoordinationDisorder:Peak Force of Knee	Time to Flexor	0.06	Reported	Y	N
21	18.Li_2024_QG-ADHD:ADHD-related medical usage	Yes to medical usage	0.17	Cohen's h from proportion	Y	N
22	18.Li_2024_QG-ADHD:ADHD-related medical usage	No to medical usage	0.04	Cohen's h from proportion	Y	Y
23	18.Li_2024_QG-ADHD:Swanson, Nolan and Pelham Rating Scale (DSNAP_INA)	Inattention doctor assessed	0.02	Cohen's d from mean	Y	N

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24	18.Li_2024_QG-ADHD:Swanson, Nolan and Pelham Rating Scale (DSNAP_HYP)	Hyperactivity/Impulsivity doctor assessed	0.33	Cohen's d from mean difference (Mean not reported)	Y	N
25	18.Li_2024_QG-ADHD:Swanson, Nolan and Pelham Rating Scale (DSNAP_ODD)	Oppositional/Defiance doctor assessed	0.19	Cohen's d from mean difference (Mean not reported)	Y	N
26	18.Li_2024_QG-ADHD:Swanson, Nolan and Pelham Rating Scale (PSNAP_INA)	Inattention parent assessed	0.11	Cohen's d from mean difference (Mean not reported)	Y	N
27	18.Li_2024_QG-ADHD:Swanson, Nolan and Pelham Rating Scale (PSNAP_HYP)	Hyperactivity/Impulsivity parent assessed	0.05	Cohen's d from mean difference (Mean not reported)	Y	N
28	18.Li_2024_QG-ADHD:Swanson, Nolan and Pelham Rating Scale (PSNAP_ODD)	Oppositional/Defiance parent assessed	0.04	Cohen's d from mean difference (Mean not reported)	Y	N
29	18.Li_2024_QG-ADHD:Traditional Chinese Medicine Symptoms	Traditional Chinese Medicine Symptoms	0.22	No means or differences reported	Y	Y
30	18.Li_2024_QG-ADHD:Behavior Rating Inventory of Executive Functin (BRIEF)	Inhibition, Emotional Control, Initiation, Working memory and Plan/Organize		No means or differences reported		Y
31	18.Li_2024_QG-ADHD:Weiss Functional Impairment Rating Scale (WFIRS)	Functional Impairment		No means or differences reported		DNR
32	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64:Beck Depression	Depression Scores	2.69	Cohen's d from mean	N	Y
33	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64:Diagnostic and	Anxiety Scores	4.94	Cohen's d from mean	N	Y
34	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64:Positive	Psychological Capital	4.50	Cohen's d from mean	N	Y
35	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64:Positive	Optimism	3.48	Cohen's d from mean	N	Y
36	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64:Positive	Hope	4.23	Cohen's d from mean	N	Y
37	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64:Positive	Self-efficacy	3.61	Cohen's d from mean	N	Y
38	23.Min_2021_QG-MentalHealth_dnb_vol34_no1_64:Positive	Resiliency	0.45	Cohen's d from mean	N	N
39	26.Rodrigues_2021_QG-Anxiety:State-Trait Anxiety Inventory for Children (STAIC)	STAI Y-1: Current Anxiety	0.44	Cohen's d from mean	Y	Y
40	26.Rodrigues_2021_QG-Anxiety:State-Trait Anxiety Inventory for Children (STAIC)	STAI Y-2: General Anxiety	0.23	Cohen's d from mean	Y	Y
41	26.Rodrigues_2021_QG-Anxiety:Salivary Cortisol	Salivary Cortisol	0.17	Reported	Y	N
42	28.Sarabzadeh_2019_TC-Autism:Movement ABC (MABC-2)	Total MABC-2 Motor Skill Score	3.52	Cohen's d from mean	N	Y
43	36.Tabeshian_2022_TC-Autism:Gilliam Autism Rating Scale 2 (GRASS-2)	Stereotypic Autistic Behavior	0.45	Reported	Y	Y
44	45.Wang_2025_TC-SpecialNeeds:Academic Performance Ranking (APR)	Pupil Rating Scale (All treatment groups aggregated)	1.17	Cohen's d from mean (Reported eta squared of .334)	Y	Y
45	45.Wang_2025_TC-SpecialNeeds:Pupil Rating Scale (PRS)	Academic Performance Ranking (All treatment groups aggregated)	0.61	Cohen's d from mean (Reported eta squared of .160)	Y	Y
46	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Inhibition	0.38	Cohen's d from mean (Reported eta squared of .144)	Y	Y
47	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Shifting	0.13	Cohen's d from mean (Reported eta squared of .067)	Y	N
48	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Emotional Control	0.27	Cohen's d from mean (Reported eta squared of .026)	Y	N
49	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Initiation	1.57	Cohen's d from mean (Reported eta squared of .033)	Y	N
50	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Working Memory	1.02	Cohen's d from mean (Reported eta squared of .390)	Y	Y
51	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Planning	0.00	Cohen's d from mean (Reported eta squared of .012)	Y	N
52	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Organization	0.32	Cohen's d from mean (Reported eta squared of .014)	Y	N
53	45.Wang_2025_TC-SpecialNeeds:Behavior Rating Inventory of Executive Functin (BRIEF)	Monitoring	0.59	Cohen's d from mean (Reported eta squared of .086)	Y	N
54	45.Wang_2025_TC-SpecialNeeds:Functional near-infrared spectroscopy (fNIRS)	Functional near-infrared spectroscopy		No means or differences reported		DNR
55	49.Zhang_2018_INREV2_TC-Depression:Patient Health Questionnaire Depression Scale (PHQ-9)	Patient Health Questionnaire Depression Scale Time Effect	1.00	Cohen's d from mean (Reported eta squared of .549)	Y	Y
56	49.Zhang_2018_INREV2_TC-Depression:Perceived Stress Scale (CPSS)	Perceived Stress Scale Time Effect	0.70	Cohen's d from mean (Reported eta squared of .319)	Y	Y
57	49.Zhang_2018_INREV2_TC-Depression:Mindful Attention and Awareness Scale (MAAS)	Mindful Attention and Awareness Scale Time Effect	0.94	Cohen's d from mean (Reported eta squared of .447)	Y	Y
58	49.Zhang_2018_INREV2_TC-Depression:Patient Health Questionnaire Depression Scale (PHQ-9)	Patient Health Questionnaire Depression Scale	2.63	Reported	N	Y
59	49.Zhang_2018_INREV2_TC-Depression:Perceived Stress Scale (CPSS)	Perceived Stress Scale	3.03	Reported	N	Y
60	49.Zhang_2018_INREV2_TC-Depression:Mindful Attention and Awareness Scale (MAAS)	Mindful Attention and Awareness Scale	5.69	Reported	N	Y
61	49.Zhang_2018_INREV2_TC-Depression:Mindful Attention and Awareness Scale (MAAS)	No Depression	1.37	Cohen's h from proportion	N	Y
62	49.Zhang_2018_INREV2_TC-Depression:Mindful Attention and Awareness Scale (MAAS)	Subthreshold Depression	1.25	Cohen's h from proportion	N	Y

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