Effects of Massage on Self-regulatory Difficulties, Tactile and Oral Abnormalities, and Parenting Stress in Children with Autism Spectrum Disorder (ASD): A Systematic Review and Meta-analysis

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Background: The Centers for Disease Control and Prevention stated that about 1 in every 44 children between the ages of 4 and 8 years old had been identified with autism spectrum disorder (ASD). Complementary interventions such as massage are crucial for the improvement of the health outcomes of ASD patients, such as abnormal sensory response; Autism Behavior Checklist; parenting stress, self-regulatory difficulties, social, language, and communication abilities; tactile or oral abnormalities; Vineland daily living skills; Vineland socialization; Childhood Autism Rating Scale; Preschool Language Scale 5th Edition (PLS-5) auditory communication; and PLS-5 expressive communication.

Purpose: We aim to systematically investigate the effects of different types of massage on self-regulatory difficulties, tactile and oral abnormalities, and parenting stress in children with ASD.

Methods: PubMed, Cochrane Library, Scopus, and Web of Science were scoured from their inception through November 15, 2022. Research comparing massage efficacy in children with ASD to other methods or a control group was included. For randomized controlled trials (RCTs), we utilized the Cochrane risk of bias tool; and for cohort studies, we used the tool developed by the National Institutes of Health. Meta-analysis was carried out with Review Manager 5.4. For our continuous data, we calculated the mean difference (MD) and 95% confidence interval (95% CI).

Results: We included 10 studies with a total number of 485 children with autism. Our analysis showed a significant decrease in the massage group regarding self-regulatory difficulties (MD = −9.15; 95% CI (−13.69 to −4.60), $p < 0.0001$). Also, the massage group showed a significant decrease in tactile or oral abnormalities compared with the control group (MD = −4.83; 95% CI (−7.86 to −1.80), $p = 0.002$). Moreover, parenting stress significantly decreased in the massage group compared to the control group (MD = −4.31; 95% CI (−7.02 to −1.61), $p = 0.002$).

Conclusion: Qigong and traditional Thai massage improved self-regulatory difficulties and decreased tactile or oral abnormalities in children with autism. Moreover, they decreased parenting stress. However, we need more RCTs with larger sample sizes with high quality to assess

the different types of massage effects on autistic children and produce more valid results. So, Qigong and traditional Thai massage could be used as a complement to educational and training interventions in children with autism.

KEYWORDS: Autism; autism spectrum disorder; ASD; Qigong; massage; traditional Thai massage; meta-analysis; systematic review

INTRODUCTION

According to the World Health Organization, 1 in every 100 children suffers from autism.[1] Moreover, the Centers for Disease Control and Prevention stated that about 1 in every 44 children between the ages of 4 and 8 years old had been identified with autism spectrum disorder (ASD).[2] ASD is a group of neurodevelopmental disorders affecting people's communication, learning ability, and social development. The word spectrum means that people with ASD can have various symptoms and disabilities.[3] Therefore, autism is considered the most prevalent neurological disorder among children. Autism also puts a heavy burden on the parents and families of ASD patients.[4]

Behavioral and social functions are closely related to sensory processing which is the way our brain receives, organizes, and responds to information from our senses, such as sight, sound, touch, smell, and taste.[5] Sensory processing disorders are conditions where the brain has trouble processing sensory information, which can cause problems with behavior and social functions. Also, sensory processing disorders are much more common in autistic patients, with rates between 43% and 95% than in the neurotypical group.[6] Autistic patients also have atypical responses to stimuli that involve social impairment that are different from what is expected or normal for most people. For example, an atypical response to loud noise could be covering your ears and screaming, or ignoring it completely. Therefore, sensory processing and ASD have a strong connection.[7] The pathophysiology of ASD and sensory processing disorder is not fully understood, but it may involve abnormal brain connectivity, neuroinflammation, oxidative stress, mitochondrial dysfunction, and genetic factors.[8]

Due to the complexity and variability of ASD's genesis, there are still no approved drugs to manage the disease's primary symptoms.[9] However, there are many types of treatment interventions available for ASD, depending on the individual's needs and goals. Some of the common categories of interventions are behavioral, developmental, educational, social-relational, psychological, and complementary approaches.[10] Moreover, Lordan et al.[11] revealed that none of the available treatments, either alone or in combination, have been able to cure ASD completely. Therefore, early investigation and complementary interventions such as massage are crucial for the improvement of the health outcomes of ASD patients, such as abnormal sensory response; Autism Behavior Checklist (ABC); parenting stress; self-regulatory difficulties; tactile or oral abnormalities; Vineland daily living skills; Vineland socialization; social, language, and communication abilities; Childhood Autism Rating Scale (CARS); Preschool Language Scale 5th Edition (PLS-5) auditory communication; and PLS-5 expressive communication.[12–14]

Massage included many techniques. Usually, it includes having someone else apply the proper pressure to specific body areas. The common types of massage are the following: Swedish massage, traditional Indian massage, traditional Thai massage, and Chinese massage.[15,16] Qigong massage is a type of massage that combines a gentle touch with breathing and movement exercises. It is based on the principles of traditional Chinese medicine and aims to balance the flow of energy (qi) in the body. Qigong massage may help with stress relief, pain management, immune system support, and overall well-being. Moreover, Thai massage is a type of massage that involves stretching, pulling, and rocking techniques to relieve tension, promote relaxation, and improve flexibility and circulation. It is sometimes called assisted yoga because the practitioner moves the client into various yoga-like poses. Thai massage may help with headaches, back pain, joint stiffness, and pain, anxiety, and energy levels.

As part of their working techniques, massage therapists push, knead, press, pat, and use their hands, forearms, and elbows. For the treatment of musculoskeletal and neurological illnesses, massage is frequently used in several nations. Research

has shown that it effectively reduces pain, eradicates fatigue, boosts mood, and alleviates several clinical disorders. Literature supports that massage may improve the symptoms of ASD children.[16,17] According to some studies, massage may have various effects on children with autism, such as decreasing touch aversion and increasing tolerance for tactile stimulation; reducing stress, anxiety, and cortisol levels; improving social skills, communication, and emotional expression; enhancing mood, relaxation, and sleep quality; and alleviating pain, muscle tension, and sensory issues.[18–20] However, the evidence for the effectiveness and safety of massage for autism is limited, and more research is needed to confirm the benefits and optimal protocols of massage for this population. Also, published literature had a different effect size regarding the effects of massage on autistic children. So we decided to do a systematic review and meta-analysis to resolve this conflict.

In this systematic review and meta-analysis, we aim to systematically investigate the effects of different types of massage on self-regulatory difficulties, tactile and oral abnormalities, and parenting stress in children with ASD.[15,19]

METHODS

Study Design

This systematic review and meta-analysis followed the Cochrane guidelines and PRISMA updates.[21,22] Meta-analysis is a type of study design that combines and analyzes the results of several previous studies on the same topic. It uses statistical methods to estimate the overall effect size and variability of the relationship between two variables or the effectiveness of an intervention.[21]

Literature Search and Data Collection

We performed the research until November 2022 using the following criteria: (Autism OR Autistic OR ASD OR "Kanner's Syndrome" OR "Kanners Syndrome" OR "Kanner Syndrome" OR "Asperger's syndrome" OR "Aspergers syndrome") AND (massage OR massages OR Qigong OR "Ch'i Kung" OR "Tui na"). We used PubMed, Cochrane Library, Scopus, and Web of Science databases to search.

Studies Selection and Eligibility Criteria

All studies that met our criteria were considered, whether they were randomized controlled trials (RCTs) or cohort studies; (i) population: children with autism; (ii) intervention: massages such as Qigong and traditional Thai massage; (iii) comparator: control; and (iv) outcomes: any evaluated outcomes from these outcomes: abnormal sensory response; ABC; parenting stress; self-regulatory difficulties; tactile or oral abnormalities; Vineland daily living skills; Vineland socialization; social, language, and communication abilities; CARS; PLS-5 auditory communication; and PLS-5 expressive communication.

Certain studies were excluded from our analysis based on the following reasons: (i) review studies were not included in the review; (ii) studies not published in the English language were excluded; (iii) studies comprising solely of abstracts were not considered; and (iv) single arm studies. After finishing the research, we removed the duplicates using the EndNote program (Clarivate, Philadelphia, PA, USA). Screening for relevance was undertaken by two separate reviewers (first the titles and abstracts, then the full texts). Moreover, to find any missed relevant articles, the reviewer revised the references of the included studies. Finally, the third author resolved any conflicts between the independent authors.

Quality Assessment

The Cochrane (Cochrane Collaboration, London, UK) risk of bias tool (version 1) was used to evaluate our included studies.[23] The following domains make up this tool: (i) detection of selection bias and other biases; (ii) allocation of arms; (iii) participant and investigator blinding; (iv) assessment of outcomes and their blinding; and (v) randomization of the population. The possibility of bias in judgment can be a high, low, or ambiguous risk of bias. In addition, the cohort studies were assessed using the National Institutes of Health tool (NIH, Bethesda, MD, USA) for risk of bias.[24] The tool was composed of 12 questions about population and sample size justification, the research question, control definition, inclusion criteria and cases, event time, blindness, and the reporting of confounders.

Data Extraction

We extracted the data into preformulated Excel sheets containing the following: (i) summary characteristics and baseline data: study id, study arms, sample size, female, n (%), age (year), description of the intervention, site of study, study design, follow-up duration, inclusion criteria, primary outcomes, and conclusion, and (ii) outcomes: abnormal sensory response; ABC; parenting stress; self-regulatory difficulties; tactile or oral abnormalities; Vineland daily living skills; Vineland socialization; social, language, and communication abilities; CARS; PLS-5 auditory communication; and PLS-5 expressive communication.

Data Analysis

Review Manager (RevMan v5.4, Cochrane Collaboration, London, UK) was used to conduct the statistical analysis. We considered the significance level at a p-value of < 0.5 level. As the outcomes data were continuous, we calculated the mean difference (MD) and 95% confidence interval (95% CI). Finally, the heterogeneity was assessed using the I-square test (I^2) and the chi-square test. We considered the data heterogeneous if the p-value of chi-square was <0.1 and the I^2 value was >50%. The fixed-effect model was used for the analysis of the homogeneous data, while the random effects model was employed for the analysis of the heterogeneous data.

RESULTS

Literature Search

Our literature search results were 204 after duplication removal from our databases. Twenty articles were involved in full-text screening after the title and abstract screening step. Ten studies matched our inclusion criteria in the qualitative synthesis, although seven studies were included in the quantitative synthesis (Figure 1). We screened manually after that, and no missing studies were discovered.

Study Characteristics

We included eight RCTs[25–32] and two cohort studies[20,33] with a total sample size of 485. Study sites varied among three countries: the United States, Italy, and Thailand. The range of age was between 3 and 6 years old. Moreover, the mean follow-up duration was 5 months, and the specific details are provided in Table 1.

The Quality of the Included Studies

Our included RCTs[25–32] had a moderate risk of bias and they are reported in Figure 2. Regarding the cohort studies,[20,33] they were of poor quality, and the detailed evaluation is provided in Table S1.

Qualitative Synthesis

Escalona et al.[25] showed that children in the massage group had fewer instances of stereotypical conduct, demonstrated more on-task and social-relatedness behavior during classroom play observations, and had fewer issues with sleep at home. The study by Jerger et al.[33] was a feasibility study which showed that the approach was feasible. If these results hold up in a larger sample, they will shed light on the brain mechanism of action behind the beneficial effects of Qigong massage on children with autism in social interaction and communication. Finally, Silva and Schalock (2013)[20] findings suggested that a Qigong massage routine can be beneficial in treating tactile impairment in young children with autism. Qigong massage was a viable route to enhance developmental outcomes in autism since there was a clear correlation between tactile impairment and self-regulatory delay before therapy and a proportionate decrease of both after treatment.

Quantitative Analysis

Abnormal sensory response

The pooled statistical analysis from our included clinical trials[20,29,31,32] showed a barely significant difference toward the massage group (MD = −3.22; 95% CI (−6.38 to −0.06), p = 0.05). The results were heterogeneous and hence assessed using the random-effect model (I^2 = 86%, p < 0.0001) (Figure 3).

And after leaving out Silva et al. (2007),[29] the results showed a non-significant difference between the two groups (MD = −3.05; 95% CI (−7.41 to 1.31), p = 0.17), and we solved the heterogeneity (I^2 = 53%, p = 0.12) (Figure S1).

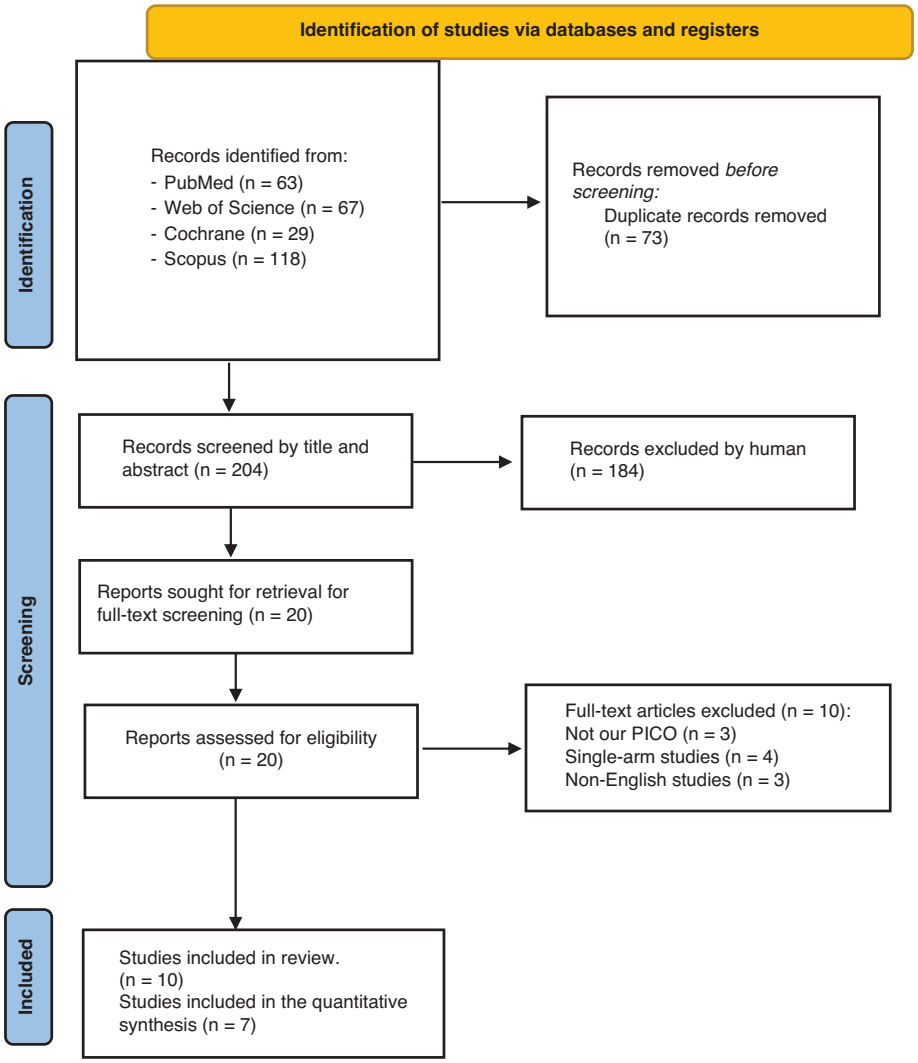

Figure 1. PRISMA flow chart. PICO: P = population/patient/problem—describes the patient group or problem of interest; I = intervention—refers to the treatment, exposure, or main intervention being considered; C = comparison—represents an alternative intervention or control that is being compared to the primary intervention (if applicable); O = outcome—specifies the expected results or what is being measured to evaluate the effectiveness of the intervention.

Autism behavior checklist

The pooled statistical analysis from our included clinical trials[27,29–32] showed a non-significant difference between the two groups (MD = −7.00; 95% CI (−16.68 to 2.68), p = 0.16). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 4%, p = 0.38) (Figure 4).

Parenting stress score

The pooled statistical analysis from our included clinical trials[20,26,31,32] showed a significant decrease in parenting stress score favoring the massage group compared with the control group (MD = −4.31; 95% CI (−7.02 to −1.61), p = 0.002). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 29%, p = 0.24) (Figure 5).

Self-regulatory difficulties

The pooled statistical analysis from our included clinical trials[20,27,31,32] showed a significant decrease in self-regulatory difficulties favoring the massage group compared with the control group (MD = −9.15; 95% CI (−13.69 to −4.60), p < 0.0001). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.99) (Figure 6).

TABLE 1. (Part 1 of 3) Summary and Baseline Characteristics of the Included Studies

Study ID	*Study Arms, Sample Size*	*Female, N (%)*	*Age (years), M (SD)*	*Description of the Intervention*	*Site*	*Follow-up Duration*	*Study Design*	*Inclusion Criteria*	*Primary Outcomes/Endpoint*	*Conclusion*
Escalona et al., 2001	Massage therapy, 10 Attention control, 10	8 (40%)	3–6 years old	Massage therapy for 15 min just before bedtime every night for 1 month.	USA	1 month	RCT	1. Children with autism 2. Under 6 years of age at the onset of the study	1. Revised Conners' Scales 2. Classroom and playground behavior observations 3. Sleep diaries	"Results suggested that the children in the massage group exhibited less stereotypic behavior and showed more on-task and social-relatedness behavior during play observations at school, and they experienced fewer sleep problems at home."
Silva et al., 2007	Qigong massage, 8 Special education program, 7	2 (13.33%)	2–6 years old	Specialist/parent-delivered Qigong massage plus special education program	USA and Italy	5 months	RCT	1. Children with autism 2. Under 6 years of age at the onset of the study	1. Cognitive domain screening test 2. Sensory profile evaluation tool 3. Vineland Adaptive Behavior Scales 4. ABC 5. Parent questionnaire (child's bowel and sleep patterns) 6. Scoring tool for Cignolini method Vineland-II 7. Sensory profile 8. Open-ended questionnaire	"Treated children experienced significant improvement of their sensory impairment ($p < 0.01$), and demonstrated increased social skills ($p < 0.04$) and basic living skills ($p < 0.02$) on standardized measures. In addition, all of the children with bowel and sleep abnormalities demonstrated improvement after treatment."
Silva et al., 2008	Qigong massage, 26 Previous controlled study, 13	5 (19.23%) 3 (23.08%)	3–6 years old	Once a week (therapist); 15 min/day (parent)	USA	5 months	Replication study	1. Younger than 6 years of age with a diagnosis of autism at the onset of the study 2. Enrolled in early intervention services 3. Without additional complicating medical diagnoses or medication such as chelating agents.	1. Vineland-II 2. ABC 3. Sensory profile 4. Open-ended questionnaire	"Results of outcomes comparing delivery by QST-trained therapists with delivery by a doctor of Chinese medicine showed that both groups improved and that there was no difference in outcome between the two groups."
Silva et al., 2009	Qigong massage, 25 Wait-list/ special education program, 21	9 (19.57%)	3–6 years old	Once a week (therapist); 15 min/day (parent)	USA	5 months	RCT	1. Age <6 years 2. Eligible for early intervention services for autism 3. No complicating medical diagnoses or chronic medication.	1. PDDBI (teacher and parent versions) 2. ABC 3. SSC	"Teacher evaluations showed that treated children had significant classroom improvement of social and language skills and reduction in autistic behavior compared with wait-list control participants. These findings were confirmed by parent data, indicating that the gains had generalized across contexts. A model and supporting data for understanding and treating sensory and self-regulation problems in autism is presented."
Silva et al., 2011	Qigong massage, 24 Wait-list/ special education program, 18	14 (33.33%)	3–6 years old	15 min/day (parent)	USA	5 months	RCT	1. Age <6 years 2. Receiving early intervention services for autism 3. No complicating medical diagnoses or chronic medication 4. Including no active medical therapies for autism such as chelation.	1. ABC 2. PDDBI 3. APSI 4. SSC	"Results indicate that the parent-delivered component of the program provided effective early intervention for autism that was suitable for delivery at home."

Table 1. (Part 2 of 3) Summary and Baseline Characteristics of the Included Studies

Study ID	*Study Arms, Sample Size*	*Female, N (%)*	*Age (years), M (SD)*	*Description of the Intervention*	*Site*	*Follow-up Duration*	*Study Design*	*Inclusion Criteria*	*Primary Outcomes/Endpoint*	*Conclusion*
Silva and Schalock, 2013	Qigong massage, 97 Wait-list/ special education program, 32	25 (19.38%)	3.87 (1.11) 4.16 (0.95)	Once a week (therapist); 15 min/day (parent)	USA	-	Retrospective cohort	1. Age under 6 years 2. Confirmation of autism by DSM-IV criteria 3. Receipt of early intervention services for autism 4. Absence of other disability 5. No psychotropic medication 6. No new autism therapies are planned during the study	1. SSC 2. APSI 3. Therapist report	"Results demonstrate that tactile impairment in young children with autism is treatable with a Qigong massage protocol. The direct relationship between tactile impairment and self-regulatory delay pretreatment, and the proportional decrease of both following treatment, suggest that tactile impairment is a cause of self-regulatory delay and that Qigong massage is a promising avenue to improve developmental outcomes in autism."
Silva et al., 2015	Qigong massage, 42 Wait-list/ special education program, 42	9 (10.71%)	2–5 years old	Once a week (therapist); 15 min/day (parent)	USA	5 months	RCT	1. Have a medical and/or educational diagnosis of autism 2. Be under the age of 6 and 3 years. Parents willing to attend the parent training session and transport the child to treatment sessions with trained staff 20 times in the first 5 months 4. Parents willing to give the 15-min massage daily 5. Parents willing not to start any new interventions unless medically necessary	1. CARS2-ST 2. PLS-5 3. Vineland-II 4. ABC 5. SSC 6. APSI 7. Beach Center Family-Professional Partnership Scale and Fidelity and Social Validation Testing	"The QST dual program for autism directed at tactile abnormalities was effective in decreasing the severity of individual sensory, behavioral, and language components of autism as well as the severity of autism overall. The intervention works by decreasing tactile and other sensory abnormalities and removing the sensory barriers to learning social/ language skills and regulating behavior. Child-to-parent bonding improved, and the experience of touch and relationship normalized for parent and child. Children were better able to make eye contact, focus, and listen, and parenting stress decreased."
Silva et al., 2016	Qigong massage, 17 Wait-list/ special education program, 16	-	2–5 years old and 6–11 years old	Once a week for 1 year (therapist); 15 min/day for 2 years (parent)	USA	5 months to 1 year	RCT	1. Children with autism	1. CARS 2. PLS 3. Vineland-II 4. ABC 5. SSC 6. Fidelity and Social Validation Testing	"This study provides evidence that the window of opportunity for treatment of tactile impairment in children with ASD remains open until at least age 11. Compared with preschool children, treatment of tactile impairment in elementary school-aged children yielded a similar improvement of social, language, and behavioral abnormalities in autism, and similar decreases in sensory problems and autism severity. Treatment was effective in lower and higher functioning groups across the age range studied."

TABLE 1. (Part 3 of 3) Summary and Baseline Characteristics of the Included Studies

Study ID	*Study Arms, Sample Size*	*Female, N (%)*	*Age (years), M (SD)*	*Description of the Intervention*	*Site*	*Follow-up Duration*	*Study Design*	*Inclusion Criteria*	*Primary Outcomes/Endpoint*	*Conclusion*
Jerger, 2018	Qigong massage, 11 Video, 6	-	4–7 years old	QST is carried out by parents for 15 to 20 min each day and supported by a trained therapist once a week for the first 20 weeks	USA	-	Prospective cohort	1. Children with autism	1. Observed Behavior 2. Sense and Self-regulation Checklist	"This study demonstrates solid protocol feasibility. If replicated in a larger sample, these findings would provide important clues to the neural mechanism of action underlying QST's efficacy for improving sensory, social, and communication difficulties in children with autism."
Piravej et al., 2009	Thai traditional massage, 30 Control, 30	6 (20%) 5 (16.67%)	4.48 (1.80) 4.84 (1.86)	-	Thailand	2 months	RCT	1. Children with autism	1. Conners' Parent Rating Scales 2. Conners' Teacher Rating Scales 3. Sleep behavior	"Over a period of 8 weeks, our findings suggested that TTM could be used as a complementary therapy for autistic children in Thailand."

ABC = Autism Behavior Checklist; APSI = Autism Parenting Stress Index; ASD = autism spectrum disorder; CARS = Childhood Autism Rating Scale; CARS2-ST = Childhood Autism Rating Scale 2nd edition standard version; M = mean; PDDBI = Pervasive Developmental Disorders Behavior Inventory; PLS = Preschool Language Scales; PLS-5 = Preschool Language Scale 5th edition; QST = Qigong sensory treatment; RCT = randomized controlled trials; SD = standard deviation; SSC = Self-regulation Checklist; TTM = Thai traditional massage.

FIGURE 2. Risk of bias graph for RCTs. RCT = randomized controlled trial.

Tactile or oral abnormalities

The pooled statistical analysis from our included clinical trials[20,27,32] showed a significant decrease in tactile or oral abnormalities favoring the massage group compared with the control group (MD = −4.83; 95% CI (−7.86 to −1.80), p = 0.002). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.96) (Figure 7).

Vineland daily living skills

The pooled statistical analysis from our included clinical trials[27,29,32] showed a non-significant difference between the two groups (MD = 1.49; 95% CI (−9.31 to 12.29),

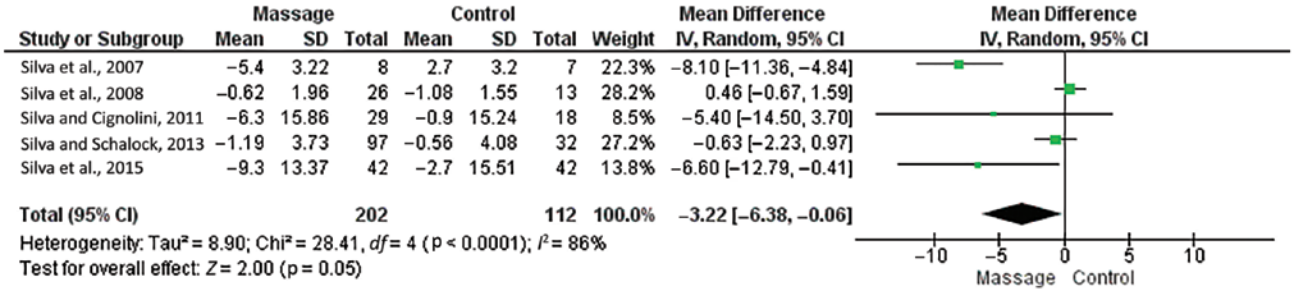

Figure 3. Forest plot of abnormal sensory response. CI = confidence interval; IV = intravenous; SD = standard deviation.

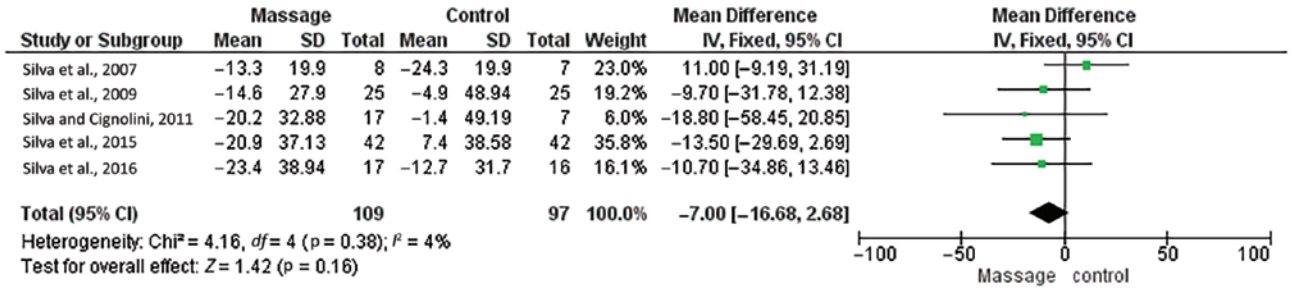

Figure 4. Forest plot of Autism Behavior Checklist. CI = confidence interval; SD = standard deviation.

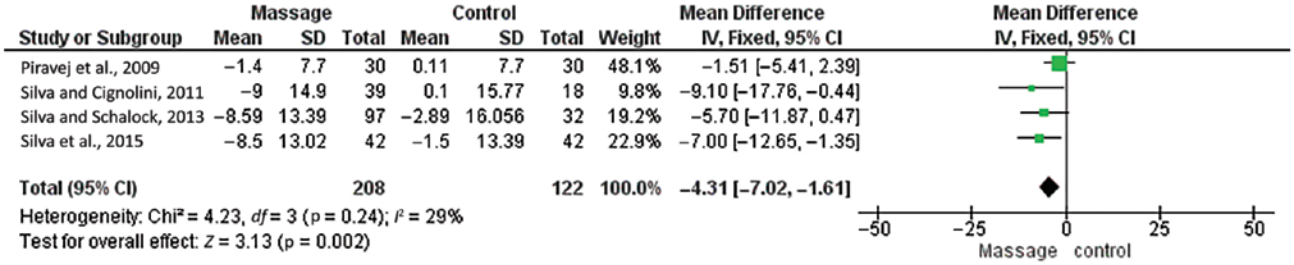

Figure 5. Forest plot of parenting stress score.

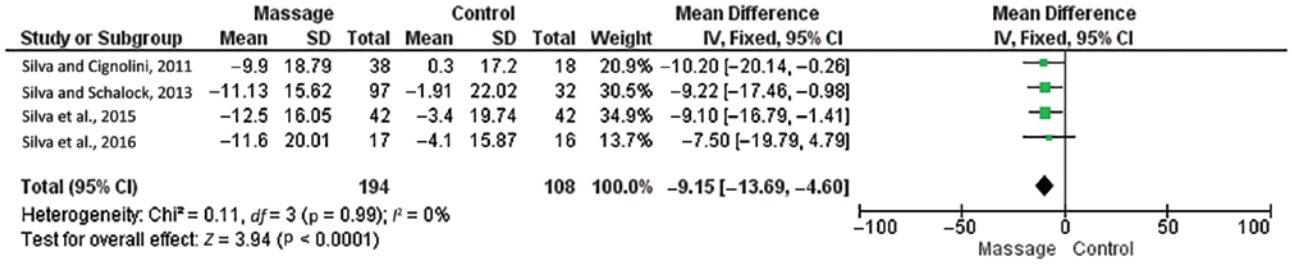

Figure 6. Forest plot of self-regulatory difficulties. CI = confidence interval; SD = standard deviation.

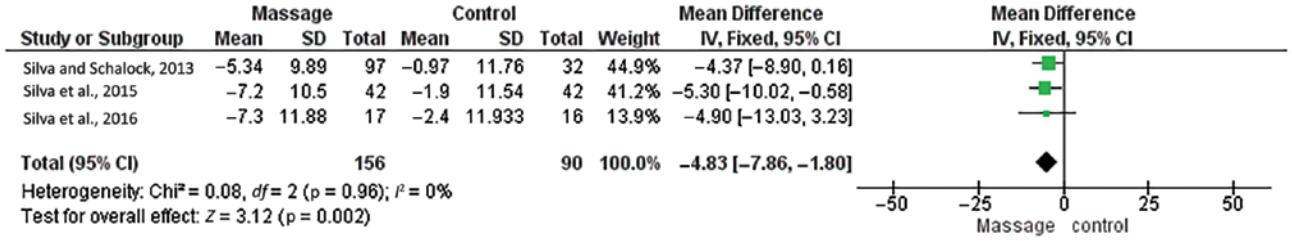

Figure 7. Forest plot of tactile or oral abnormalities. CI = confidence interval; SD = standard deviation.

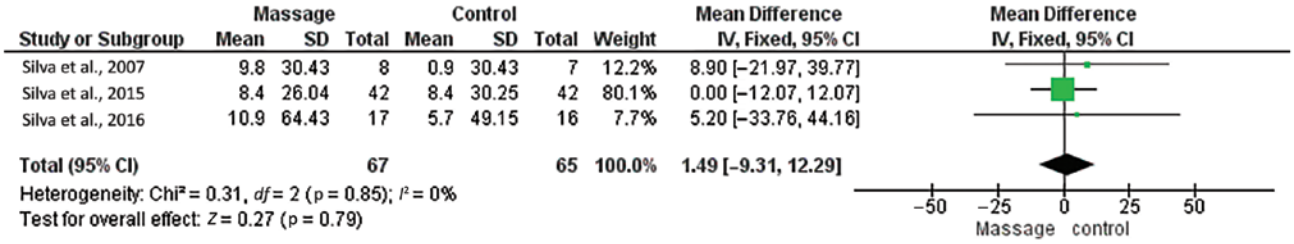

Figure 8. Forest plot of Vineland daily living skills. CI = confidence interval; SD = standard deviation.

p = 0.79). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.85) (Figure 8).

Vineland socialization

The pooled statistical analysis from our included clinical trials[27,29,32] showed a non-significant difference between the two groups (MD = 2.08; 95% CI (−7.93 to 12.09), p = 0.68). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.99) (Figure S2).

Social, language, and communication abilities

The pooled statistical analysis from our included clinical trials[30,31] showed a non-significant difference between the two groups (MD = 2.44; 95% CI (−3.72 to 8.60), p = 0.44). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.83) (Figure S3).

Childhood autism rating scale

The pooled statistical analysis from our included clinical trials[27,32] showed a non-significant difference between the two groups (MD = −0.90; 95% CI (−4.46 to 2.66), p = 0.62). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.81) (Figure S4).

PLS-5 auditory communication

The pooled statistical analysis from our included clinical trials[29,32] showed a non-significant difference between the two groups (MD = 2.02; 95% CI (−4.99 to 9.03), p = 0.57). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.96) (Figure S5).

PLS-5 expressive communication

The pooled statistical analysis from our included clinical trials[29,32] showed a non-significant difference between the two groups (MD = 0.60; 95% CI (−6.09 to 7.30), p = 0.86). The results were homogenous and hence assessed using the fixed-effect model (I^2 = 0%, p = 0.87) (Figure S6).

DISCUSSION

Our results showed some significant values that indicate the value of massage therapy as complementary to other standard therapies in improving the sensory and social interactions of autistic children, such as auditory communication, expressive communication, social abilities, language abilities, communication abilities, and living skills. The effects were significant on behavior and self-discipline (self-regulatory difficulties, parenting stress) in the autistic patients who applied to the massage group.

The physiology of massage on ASD symptoms is not fully understood, but some possible explanations are as follows: (i) massage may provide deep pressure and tactile stimulation that can calm the nervous system and reduce sensory overload in children with ASD; (ii) massage may decrease the levels of cortisol, a hormone that is associated with stress, anxiety, and inflammation. Cortisol may worsen the symptoms of ASD, such as behavioral problems, gastrointestinal issues, and immune dysfunction. (iii) Massage may improve blood circulation and oxygen delivery to the brain and other organs. This may enhance the brain function and cognitive abilities of children with ASD. (iv) massage may stimulate the release of endorphins, neurotransmitters that are involved in pain relief and mood regulation. Endorphins may help children with ASD cope with pain, discomfort, and negative emotions.[34] We had different kinds of massage, one[26] about traditional Thai massage and the other about Qigong massage, although we believe the effect is not about the technique of massage or how skilled the therapist could be but

about tactile stimulation and touch that can cause different stimuli to the body.[18] Another study showed the influence of massage on brain regions related to stress and emotional regulations.[35]

Although we had some promising outcomes, other scales showed non-significant values in the same social interactions as Vineland Adaptive Behavior Scales (daily living, socialization) and social, language, and communication abilities. These findings could minimize the effect of massage that the last systemic review stated.[19] Even the ABC, which measures important values, did not show any significant difference in this outcome in a study,[29] despite the authors' belief that the educational program that both groups received reduced autistic behavior. These results indicate the need for more research to confirm and generalize the effect of massage alone on autistic children.

This study had limitations, which we could begin with the low quality of included and lack of variations as we depend on one author and his team on six studies. There is a difference in the type of technique, duration, and frequency of massage. Moreover, trained parents gave the massage with themselves in some cases; however, this did not have a big effect on results. One of the outcomes is subjective questionnaires (CARS) that are used in the diagnosis of autism mainly not to follow-up with patients and see the change that happened.[36] There is a difference in the baseline characteristics of the included studies as most of the included children are boys. However, this could be understood as the prevalence ratio of ASD of males to females is about 3:1 and can even reach 4:1.[37] Although we had these limitations, we had some strengths; the numbers of statistical analyses give us high-quality data that can build, and our study is the first meta-analysis that discusses in detail on the benefits of massage on autistic children as a complementary treatment to standard therapy that is mainly by a special educational program.

Other studies also evaluated the effect of massage along with other strategies. They compared massage with watching videos or reading before bedtime and revealed that the massage group had a better effect.[25,33] One study (2008) with the same population and intervention could not involve it as a control group of the study was from a prior case series study.[28] Our recommendations are further studies with good methods to establish and generalize the results of outcomes, we emphasize the need for more well-designed RCTs that directly compare the different types of massage and control groups to obtain generalizable results supported by a high level of evidence.

CONCLUSIONS

When used as a complement, Qigong and traditional Thai massage improved self-regulatory difficulties, and decreased tactile or oral abnormalities in children with autism. Moreover, they decreased parenting stress. However, we need more RCTs with larger sample sizes with high quality to assess the different types of massage effects on autistic children.

CONFLICT OF INTEREST NOTIFICATION

The authors declare there are no conflicts of interest.

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APPENDICES

Appendix A

TABLE S1. NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies

Study ID	*1. Was the research question or objective in this paper clearly stated?*	*2. Was the study population clearly specified and defined?*	*3. Was the participation rate of eligible persons at least 50%?*	*4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?*	*5. Was a sample size justification, power description, or variance and effect estimates provided?*	*6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?*	*7. Was the time frame sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?*	*8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (eg, categories of exposure, or exposure measured as continuous variable)?*	*9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?*	*10. Was the exposure(s) assessed more than once over time?*	*11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?*	*12. Were the outcome assessors blinded to the exposure status of participants?*	*13. Was loss to follow-up after baseline 20% or less?*	*14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?*	*Total Score*	*Quality rating: good (11-14 points) or fair (7.5-10.5 points) or poor (0-7 points)*
	Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*	*Yes/No/Not reported (NR) or cannot determine (CD) or not applicable (NA)*		
Jerger, 2018	Yes	Yes	Yes	No	No	Yes	CD	NA	NA	NA	CD	NR	Yes	CD	6	Poor
Silva, 2013	Yes	Yes	Yes	Yes	Yes	Yes	CD	NA	NA	NA	CD	NR	Yes	CD	7	Poor

Reviewers used the study rating tools on the range of items included in each tool to judge each study to be of "good," "fair," or "poor" quality. The ratings on the different items were used by the reviewers to assess the risk of bias in the study due to flaws in study design or implementation. In general terms, a "good" study has the least risk of bias, and results are considered to be valid. A "fair" study is susceptible to some bias deemed not sufficient to invalidate its results. The fair quality category is likely to be broad, so studies with this rating will vary in their strengths and weaknesses.

A "poor" rating indicates significant risk of bias. Studies rated poor were excluded from the body of evidence to be considered for each CQ. The only exception allowed was if there was no other evidence available, then poor quality studies could be considered. However, this exception was not applied in this project because there were no situations found where only poor quality studies were available for a body of evidence for a particular CQ.

Appendix B

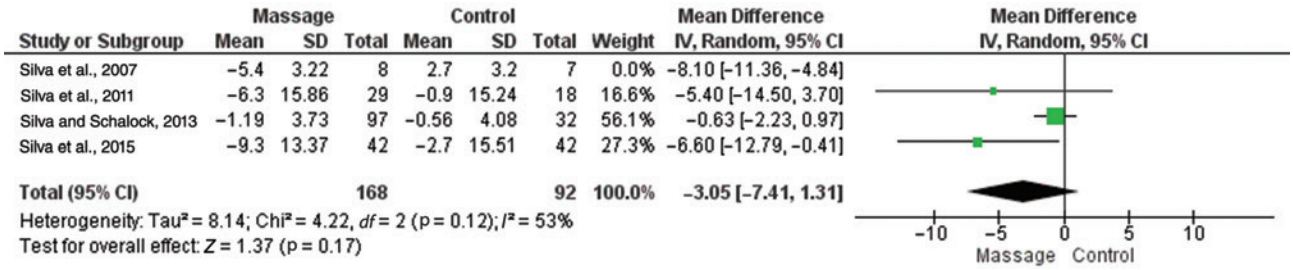

Figure S1. Forest plot of abnormal sensory response after leaving out Silva et al., 2007.

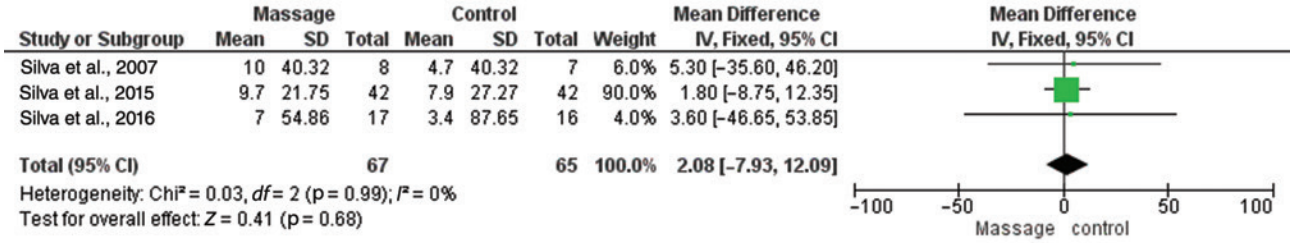

Figure S2. Forest plot of Vineland socialization.

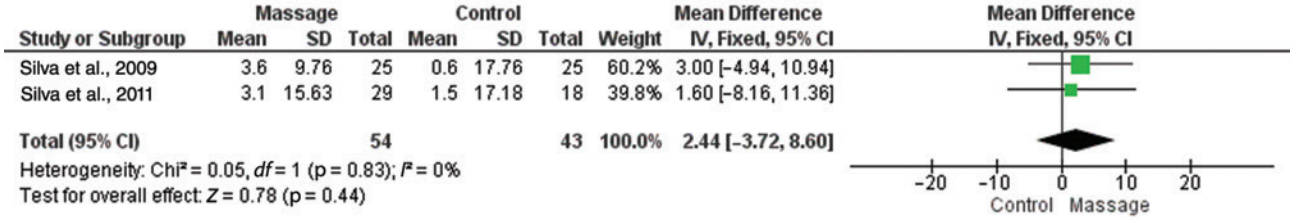

Figure S3. Forest plot of Social, Language, and Communication Abilities.

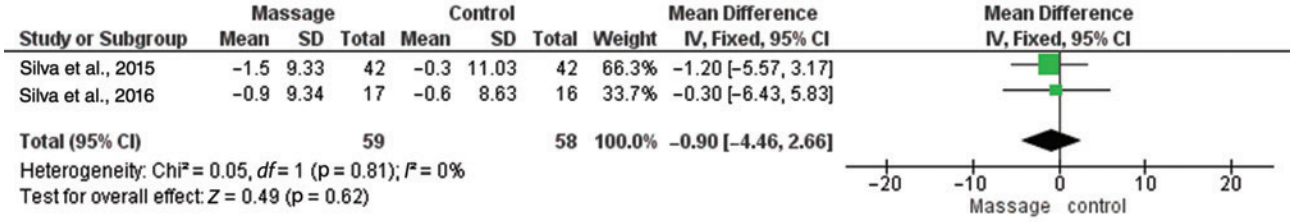

Figure S4. Forest plot of Childhood Autism Rating Scale.

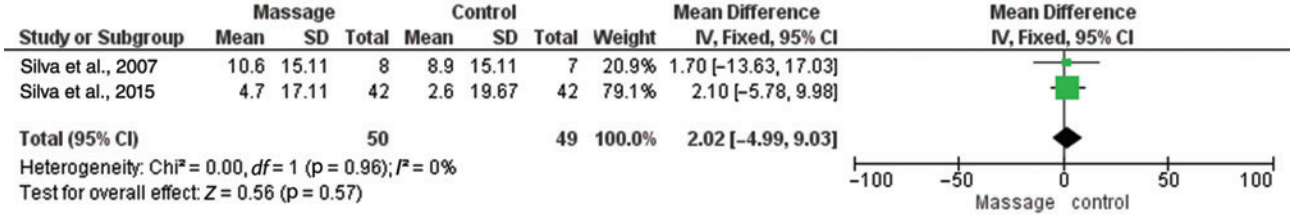

Figure S5. Forest plot of PLS-5 auditory communication.

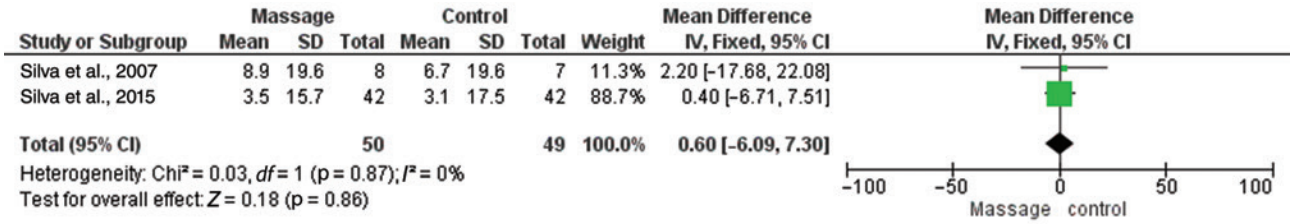

Figure S6. Forest plot of PLS-5 expressive communication.