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Masters Program in Public Health, Universitas Sebelas Maret
Meta Analysis

Meta-Analysis the Effect of Sensory Integration Therapy on Sensoric and Motoric Development in Children with Autism Spectrum Disorder

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ABSTRACT

Background: It is estimated that 90% of children diagnosed with ASD will show impaired sensory processing. Children with sensory processing problems present with delayed motor development which is caused by an underlying disorder in their ability to interpret sensations. Sensory integration therapy is one of the therapeutic methods to overcome sensory and motor problems. This study aims to estimate the effect of sensory integration therapy on sensory and motor development in children with autism spectrum disorders.
Subjects and Method: This research was conducted using a systematic review study design and a meta-analysis conducted with PRISMA flow diagrams. The article search process was carried out between 2011-2021 using databases from PubMed, Science Direct, AJOT, Springer Link, and Google Scholar. The keywords used are "sensory integration" OR "sensory integration therapy" OR "ayres sensory integration" OR "sensory intervention" OR "sensory stimulation" AND "sensory processing" OR "sensory skills" OR "sensory system" AND "motor skills " OR "motor developmental" AND "autism spectrum disorder" OR "autism". Based on the database, there were 16 articles that met the inclusion criteria. The study design used was a Randomized Control Trial (RCT). The analysis was carried out using RevMan 5.3 software.
Results: The meta-analysis is of 16 articles consisting of the continents of Asia, America, and Australia. Results showed that sensory integration therapy improved sensory development (SMD = 0.14; 95% CI -0.64 to 0.92; p = 0.73) and motor development (SMD = 0.42; 95% CI -0.27 to 1.11; p = 0.24).
Conclusion: Sensory integration therapy did not significantly improve sensory and motor development in children with autism spectrum disorders.

Keywords: sensory integration therapy, sensory, motor, autism, meta-analysis

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BACKGROUND

Autism Spectrum Disorder (ASD) or more commonly called autism is a developmental disorder of brain function that affects language development, communication skills both verbal and non-verbal, social interaction, motor behavior, emotions, and sensory perception (Hodges et al., 2020). Clinically, people with autism have neurodevelopmental disorders characterized by

deficits in social communication and limited interests and repetitive behaviors (APA, 2013).

In 2018, the Centers for Disease Control and Prevention (CDC) in 2018 reported that 1 in 59 children in the United States had ASD (Baio et al., 2018). In 2012 in Atlanta the number of children with autism was estimated at 1 in 88 children. According to data from the World Health Organization (WHO) in 2018 predicts 1 in 160 children in the world to suffer from ASD. In Indonesia, the number of people with autism is increasing. Based on the projections of the Central Statistics Agency (BPS), Indonesia's population in 2018 was more than 265 million with a population growth rate of 1.19%, it is estimated that people with ASD (Autism Spectrum Disorder) in Indonesia are 3.1 million people with the addition of 500 new people/year (Simbolon et al., 2020). It is estimated that more than 90% of children diagnosed with ASD will show impaired sensory integration (Geschwind, 2009; Marco et al., 2011).

Sensory integration (SI) is the process of organization and interpretation carried out by the brain when it receives sensory information from outside the body. Sensory information can be in the form of touch, movement, sight, sound, smell, and taste (Camarata et al., 2020). Children with sensory processing disorders report being slow to respond to sensations, showing little or no response, and/or requiring more intense stimuli to respond to environmental sensetions such as not responding to calls and having difficulty feeling pain when injured, thirsty, or hungry (Miller et al., 2014).

Ben-Seasson et al (2019) said that children have insatiable sensory needs, far beyond normal children, and often even do not pay attention to their safety such as always moving (unable to sit still), while moving children look very happy, like touching people or objects around, likes to change activities, ignores dirty face or hands, and has difficulty focusing attention. This behavior can have a negative impact on daily activities.

Children with sensory processing problems present with motor developmental delays such as difficulty initiating, planning, sequencing, and interpreting sensory information for motor planning in completing daily activities (Roley et al., 2015). Other impacts of children who experience motor problems are poor coordination skills, weak muscles, stiff muscles, poor posture, limited motor planning and sequences, and the inability to carry out tasks (Camarata et al., 2020).

Sensory integration therapy is a therapeutic method to help children with sensory disorders. Based on the theory of Ayres (1972), sensory integration therapy is a therapy method commonly used by occupational therapists to improve children's ability to process and integrate sensory information. During therapy sessions, children will be exposed to sensory stimuli in a repetitive and structured manner. Over time, the child's brain is expected to experience adaptations so that it can process and respond to sensory stimuli better (Case -Smith et al., 2015). In children with Autism Spectrum Disorder (ASD), disturbances in processing sensory impulses can cause problems that affect motor and behavioral development. These problems can cause children to be less sensitive or even too sensitive to sensory stimuli around them (Myles, 2007; Pfeiffer et al., 2011).

Kashefimehr et al., (2018) states that sensory integration therapy can improve occupational performance and development of sensory processing in ASD children. On motor development skills, the intervention group scored significantly higher. Karim & Mohammed (2015) also

reported that sensory integration therapy was able to improve fine and gross motor development.

The systematic review conducted by May-Benson & Koomar (2010) with 27 review studies showed that sensory integration therapy had a positive effect on motor skills, socialization, attention, behavioral control, reading skills, participation in game activities, and achievement of life goals.

Sensory integration therapy has shown effectiveness but most of the literature shows inconsistent terminology coverage between studies, limited high quality evidence, small sample, and design limitations (Miller et al., 2007; Schaaf et al., 2018).

Based on an understanding of the effectiveness of sensory integration therapy to improve sensory and motor development, the author are interested in conducting a systematic review and meta-analysis of sensory integration therapy. This study aimed to provide evidence of the effect of sensory integration therapy on sensory and motor development.

SUBJECTS AND METHOD

1. Study Design

This was a systematic review and meta-analysis using PRISMA flow diagram guidelines. The article search process was carried out between 2011-2021 using databases from PubMed, Science Direct, AJOT, Springer Link, and Google Scholar. The keywords used are “sensory integration” OR “sensory integration therapy” OR “ayres sensory integration” OR “sensory intervention” OR “sensory stimulation” AND “sensory skills” OR “sensory” OR “sensory system” AND “motor skills” OR “motor developmental” AND “autism spectrum disorder” OR “autism”.

2. Inclusion Criteria

This study has inclusion criteria including: full paper articles with Randomized Controlled Trial (RCT), intervention given is sensory integration therapy, research subjects are children with Autism Spectrum Disorder, age range of research subjects <17 years, research outcome measurement using standardized instruments.

3. Exclusion Criteria

This study has exclusion criteria, including: the article is not full text, the article does not use English, the article was published before 2011.

4. Operational Definition of Variables

Articles included in the study were PICO-adjusted. The search for articles was carried out by considering the feasibility defined using the PICO model, namely Population: autism spectrum disorder children, Intervention: sensory integration therapy, Comparison: no sensory integration therapy, and Outcome: increased sensory and motor development.

Sensory development is the ability to integrate sensory information to perform daily activities as measured by a sensory profile.

Motor development is a person's ability to control physical movements through coordinated nerve centers, nerves, and muscles as measured by standardized instruments.

Sensory integration therapy is a therapy that provides sensory stimuli repeatedly in order to process and respond to sensory stimuli better as measured by Evaluation in Ayres Sensory Integration (EASI).

5. Instrument

The study used PRISMA flow diagram guidelines and article quality assessment using the Critical Appraisal Checklist for RCT Study tools (CEBM, 2014).

6. Data Analysis

Data analysis in this study was carried out using the Review Manager application (RevMan 5.3) to calculate the effect size and

heterogeneity of the study. The results of data processing are presented in the form of forest plots and funnel plots.

RESULTS

The article review process uses the PRISMA flow diagram which can be seen in Figure 1. The total articles obtained were 16 articles. Articles were obtained from 3 continents, namely Asia with 6 articles, America with 10 articles, and 1 article from Australia. The next step is to assess the quality of research using the Critical Appraisal Checklist for RCT Study tools and then carry out the process of quantitative meta-analysis using RevMan 5.3.

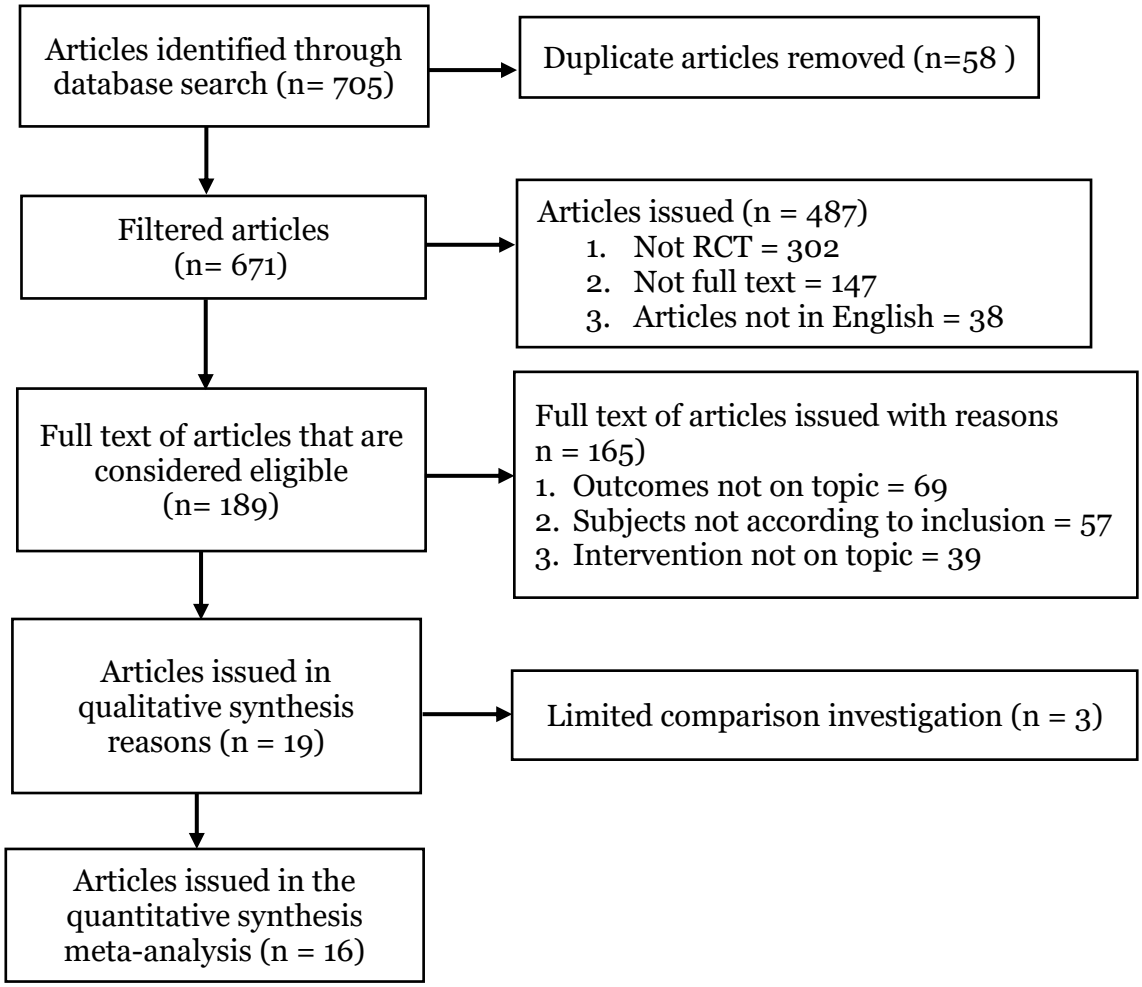

Figure 1. PRISMA Flow Diagram

1. The effect of sensory integration therapy on the sensory development of children with autism spectrum disorders

a. Forest Plot

Figure 2 shows that the heterogeneity between experiments is quite high (I^2= 93%; p <0.001) so the analysis uses the Random Effects Model (REM). The provision of sensory integration therapy in ASD children was able to increase sensory development by 0.14 times than the no SIT intervention. These results were not statistically significant (SMD= 0.14; 95% CI -0.64 to 0.92; p = 0.73).

Table 1 on the effect of sensory integration therapy on the sensory development of children with autism spectrum disorders

Author (Year)	Country	Sample	Population	Instrument	Results	
					Intervention	Comparison
Fazlioglu & Baran, 2011	Turkey	I = 15 C = 15	ASD	SEF	SI Mean = 66.5 SD = 11.4	No SI Mean = 97.3 SD = 17.8
Hana & Kim, 2019	South Korea	I = 17 C = 17	ASD	SSP	SIT Mean = 57.99 SD = 10.04	No SI Mean = 49.38 SD = 8.64
Kashefimehr et al., 2017	Iran	I = 16 C = 15	ASD	SP	SIT Mean: 51 SD: 7.22	Routine school OT Mean: 58.53 SD: 10.02
Liu, 2013	US	I = 32 C = 32	ASD	SSP	SI Mean = 120.07 SD = 21.95	No SI Mean = 83.96 SD = 15.23
Miller et al., 2011	US	I = 7 C = 10	ASD	SSP	SI Mean = 2.76 SD = 1.84	Activity Protocol Mean = 2.60 SD = 2.02
Mills et al., 2020	Australia	I = 13 C = 17	ASD	SSP	SI Mean : 87.96 SD : 4.1	Teacher directed Mean : 85.82 SD : 7.16
Padmanabha et al., 2018	India	I = 21 C = 19	ASD	SSP	SI Mean: 19.47 SD: 3.47	Standart therapy Mean: 25.21 SD: 4.22
Pfeiffer et al., 2011	USA	I = 20 C = 17	PDD-Nos	SPM	SI Mean : 39.36 SD : 4.97	Fine motor activity Mean : 24.60 SD : 4.87
Rabeyron et al., 2020	UK	I = 19 C = 17	ASD	SSP	SIT Mean = 2.28 SD = 0.9	No SIT Mean = 3.4 SD = 0.6
Roley et al., 2015	Los Angeles	I = 46 C = 26	ASD	SPM	SI Mean = 69 SD = 7.1	No SI Mean = 62 SD = 7.2
Tavassoli, 2012	UK	I = 38 C = 42	ASD	SSP	SIT: Mean: 6.47 SD: 3.36	No SIT Mean: 6.13 SD: 2.60

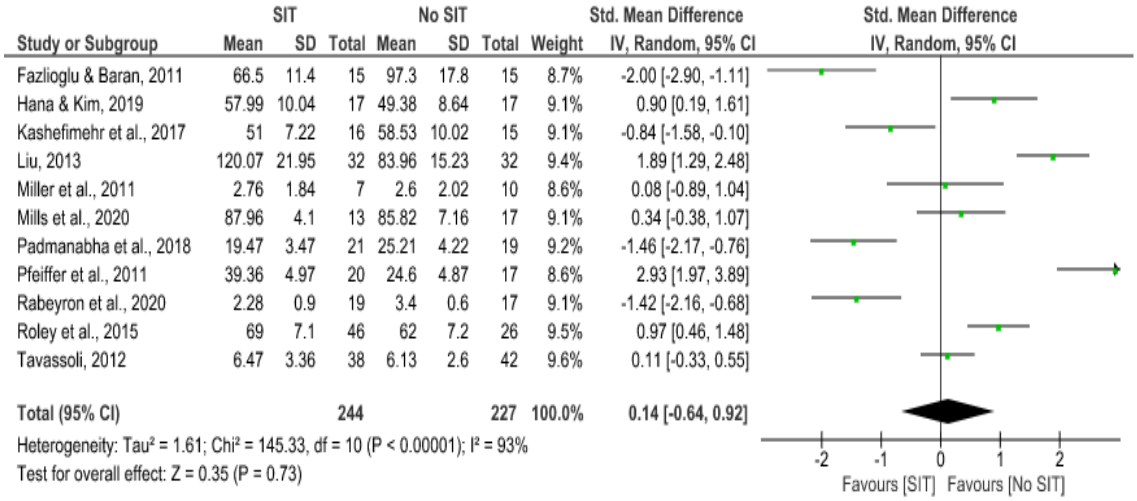

Figure 2. Forest plot of the effect of sensory integration therapy on sensory development in children with autism spectrum disorders

b. Funnel plot

Figure 3 funnel plot graph of the effect of sensory integration therapy on sensory development in children with autism spectrum disorders showing publication bias which is indicated by the asymmetry of the right and left plots.

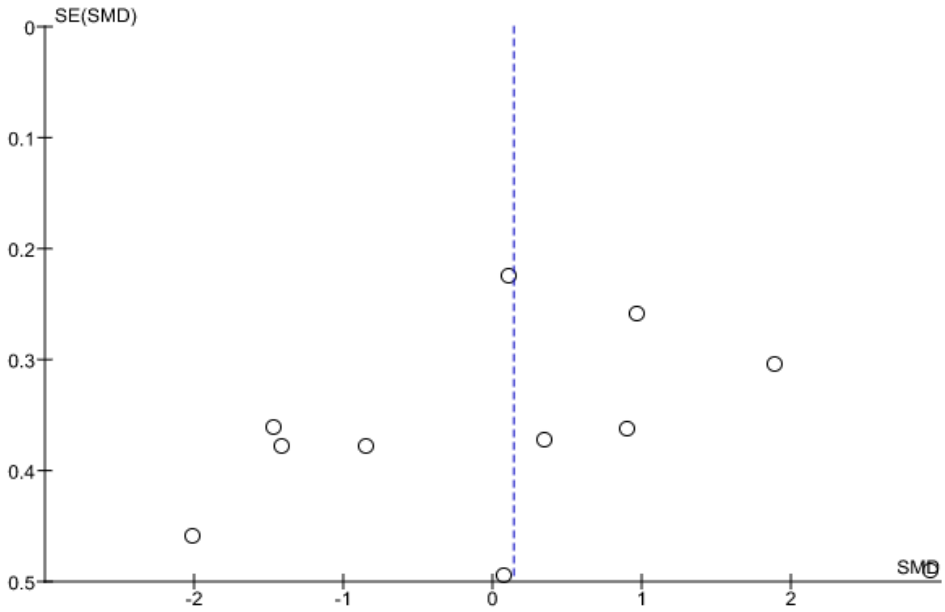

Figure 3. Funnel plot of the effect of sensory integration therapy on sensory development in children with autism spectrum disorders

2. The effect of sensory integration therapy on the motor development of children with autism spectrum disorders

a. Forest Plot

Based on the results of the analysis in Figure 4.6, it shows that the heterogeneity between experiments is quite high (I^2= 87%; p <0.001) so the analysis uses the Random Effects Model (REM). The provision of sensory integration therapy in ASD children was able to increase motor development by 0.42 times than the no SIT intervention. These results were not statistically significant (SMD = 0.42; 95% CI -0.27 to 1.11; p = 0.24).

b. Funnel Plot

Based on Figure 5, the funnel plot graph of the effect of sensory integration therapy on the motor development of children with autism spectrum disorders shows publication bias which is indicated by the asymmetry of the right and left plots.

Table 2. The effect of sensory integration therapy on motor development of children with autism spectrum disorder

Author (Year)	Country	Sample	Population	Instrument	Results	
					Intervention	Comparison
Beevi et al., 2020	India	I = 30 C = 30	ASD	GMA	SIT Mean = 37.5 SD = 8.1	No SIT Mean = 29.4 SD = 6.5
Hana & Kim., 2019	South Korea	I = 17 C = 17	ASD	PDMS-2	SIT Mean = 84.11 SD = 6.91	No SIT Mean = 76.50 SD = 6.43
Kashefimehr et al., 2017	Iran	I = 16 C = 15	ASD	SCOPE	SIT Mean: 12.31 SD: 2.72	No SIT Mean: 12.66 SD: 2.66
Lourenco, 2015	Portugal	I = 8 C = 8	ASD	BOT-2	SIT: Trampoline based Mean: 17.88 SD: 12.495	No SIT Mean: 26.13 SD: 8.254
Liu, 2013	US	I = 32 C = 32	ASD	MABC-2	SIT Mean = 4.06 SD = 2.64	No SIT Mean = 4.03 SD = 2.59
Miller et al., 2011	US	I = 7 C = 10	ASD	GAS	SI Mean = 37.37 SD = 9.10	Activity Protocol Mean = 13.59 SD = 13.02
Padmanabha et al., 2018	India	I = 21 C = 19	ASD	CGAS	SI Mean : 60.14 SD : 3.47	Standart therapy Mean : 51.53 SD : 4.22
Sarabzadeh et al., 2019	Iran	I = 9 C = 9	ASD	M-ABC-2	SI Mean = 34.30 SD = 3.48	No SI Mean = 61.38 SD = 7.38
Schaaf et al., 2013	USA	I = 17 C = 15	ASD	GAS	SI Mean: 56.53 SD: 12.38	UC Mean: 42.71 SD: 11,21
Srinivasan et al., 2015	USA	I = 12 I = 12	ASD	BOT-2	SI Mean = 44.52 SD = 10.83	Robotic group Mean = 41.73 SD = 12.02

a. Forest Plot

Based on the results of the analysis in Figure 4.6, it shows that the heterogeneity between experiments is quite high (I^2= 87%; p <0.001) so the analysis uses the Random Effects Model (REM). The provision of sensory integration therapy in ASD children was able to increase motor development by 0.42 times than the no SIT intervention. These results were not statistically significant (SMD = 0.42; 95% CI -0.27 to 1.11; p = 0.24).

b. Funnel Plot

Based on Figure 5, the funnel plot graph of the effect of sensory integration therapy on the motor development of children with autism spectrum disorders shows publication bias which is indicated by the asymmetry of the right and left plots.

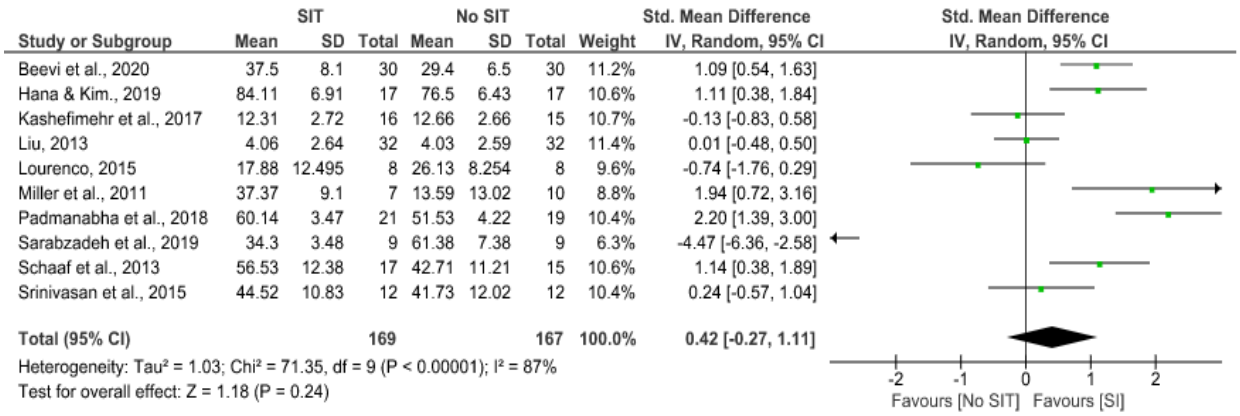

Figure 4. Forest plot of the effect of sensory integration therapy on motor development in children with autism spectrum disorders

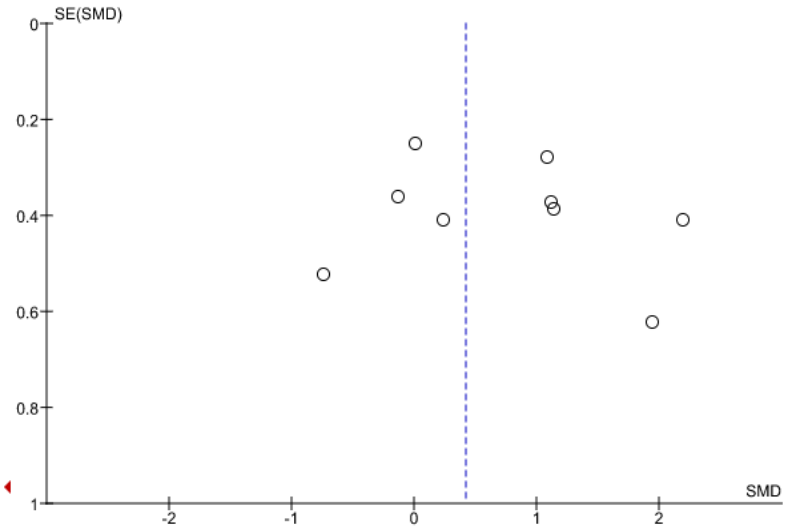

Figure 5. Funnel plot of the effect of sensory integration therapy on motor development of children with autism spectrum disorders

DISCUSSION

This research was conducted using a systematic review and meta-analysis study design by synthesizing the evidence needed to provide information in clinical decision-making and policy (Mikolajewicz, 2019). Systematic review and meta-analysis are research synthesis study designs that are at the highest level in the research hierarchy that provide the strongest scientific evidence. The synthesis research itself is carried out systematically which will help gather the best information currently available (Smith & Pattanayak, 2002). Inclusion and exclusion criteria can increase the internal and external validity of this study.

The results of the research are presented in the form of forest plots and funnel plots. Forest plots can show effect sizes and 95% confidence intervals or display results from meta-analysis studies (Makowski et al., 2019). The forest plot graph contains point estimates, confidence intervals, study weights and statistical significance values (Woodall, 2014). The funnel plot shows the effect size and precision of the effect size and makes it possible to evaluate the possibility of publication bias in the form of a sym-

metrical triangular graphic (Makowski et al., 2019; Li et al., 2020).

This systematic review and meta-analysis research raised the theme of the effect of sensory integration therapy on sensory and motor development in children with autism spectrum disorders. The intervention was designed to improve sensory and motor development in children with autism spectrum disorders with a randomized controlled trial study design. This research is useful to identify more clearly about the magnitude of the effect of sensory integration therapy on the sensory and motor development of children with autism spectrum disorders.

In this systematic review, 16 articles with 5 duplicate articles for intervention studies were identified worldwide from 2011 to 2021. This study analyzed articles using the Mean SD measure. The results of the systematic review and meta-analysis are presented in the form of forest plots and funnel plots. The forest plot visually displays the magnitude of variation (heterogeneity) between study results. The funnel plot shows the relationship between the effect size of study and the sample size or standard error of the effect size of the various studies studied (Murti, 2018). The possibility of publication bias in the funnel plot can be seen from the asymmetry of the number of studies on the right and left sides.

1. The Effect of Sensory Integration Therapy on the Sensory Development of Children with Autism Spectrum Disorder

11 articles with randomized controlled trials study design as a source of meta-analysis of the effect of sensory integration therapy on sensory development in children with autism spectrum disorders. The forest plot results show that the heterogeneity between experiments is quite high (I^2= 93%; p <0.001) so that the analysis uses the Random Effects Model (REM). The provision of sensory integration therapy in ASD children was able to increase sensory development by 0.14 times than the no SIT intervention but the results were not statistically significant (SMD= 0.14; 95% CI -0.64 to 0.92; p= 0.73).

Statistically insignificant results were obtained which are in line with research by Vaijayanthimala & Judie (2014) concluding that sensory sensitivity is something that is individual and subjective so that only people who suffer can explain it (Farrag, 2018). The sensory stimulus given is the same but the response of each individual is different. Sensory perceived by respondents varied in the treatment group and the control group. Sensory responses that are emitted excessively because the child feels uncomfortable, resulting in less adaptive behavior (Rahmi et al., 2018). This is in accordance with the gate control theory which states that the sensory evoked depends on the work of the central nervous system (Osório et al., 2014).

Murdock et al. (2014) reported the effect of sensory integration therapy on sensory responses in children with autism spectrum disorders stated that there was no significant difference between the treatment and control groups. Changes noted in respondents could not be attributed to age, diagnosis, or sensory response.

This study is in line with Miller et al. (2007) and Schaaf et al., (2018) in which sensory integration therapy has shown effectiveness but inconsistent terminology coverage, limited high-quality evidence, small sample, and design limitations have led to the results are not significant. According to Bowker et al., (2011) that sensory integration therapy is not a one-size-fits-all intervention but must look at other factors in its application. Although some literature discusses disagreement about the benefits of sensory interventions, sensory interventions

continue to be the most commonly used interventions to manage sensory, behavioral, and therapeutic settings.

In individuals with ASD, several studies that show a positive effect often prove problematic methodology (Lang et al., 2012) or the effect of documenting through parental reports rather than through objective behavior measures so that the results are subjective. This is what makes the effectiveness of therapy biased (Baranek, 2012). Research efforts are currently underway to utilize better methodologies even with high control and objective measurements (Pfeiffer et al., 2011; Rie & Heflin, 2009; Watling & Dietz, 2007). On the other hand, studies on sensory-based techniques such as using weighted vests and gym balls have used objective behavioral measurements but the results also show negative results and are constrained by small sample sizes (Bagatell et al., 2010).

2. The Effect of Sensory Integration Therapy on the Motor Development of Autism Spectrum Disorder Children

In 10 research articles with randomized controlled trials study design as a source of meta-analysis of the effect of sensory integration therapy on motor development in children with autism spectrum disorders. The results of the forest plot show that the heterogeneity between experiments is quite high (I^2= 87%; p<0.001) so the analysis uses the Random Effects Model (REM). The provision of sensory integration therapy in ASD children was able to increase motor development by 0.42 times than the no SIT intervention. The results were not statistically significant (SMD= 0.42; 95% CI -0.27 to 1.11; p = 0.24).

Monica (2015) explains that sensory integration therapy does not have a motor effect on children with autism because it is influenced by the level of motor skills from moderate to severe. Children who have moderate motor problems after the intervention experienced changes, but children who had severe motor problems did not experience any changes. In addition, it is also influenced by the duration of therapy which is too short.

Drobnyk study (2019) showed that sensory integration therapy showed small improvements in motor skills because the sample included in the study was small, the timing of the intervention was intermittent or inconsistent, and the health conditions of the children participating in the study were not taken into account, for example. There are children who have active seizure disorders and gastrointestinal problems that will affect their participation.

AUTHOR CONTRIBUTION

Ayu Fitriyaningsih is the main researcher who selects the topic, searches and collects research data. Yulia Lanti Retno Dewi and Rita Benya Adriani analyze data and review research documents.

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This study is self-funded.

CONFLICT OF INTERESTS

There is no conflict of interest in this study.

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