Biological Forum – An International Journal **15(5): 1705-1708(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effectiveness of Early Multimodal Sensory Stimulation on Neuro-Motor Outcomes in Preterm Infants: A Systematic Review

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(Received: 15 March 2023; Revised: 13 April 2023; Accepted: 03 May 2023; Published: 20 May 2023)
(Published by Research Trend)

ABSTRACT: The main aim of this systematic review was to evaluate the evidences on effectiveness of early multimodal sensory stimulation programs in preterm infants, compared to other conventional therapies, to improve neuromotor outcomes.
The databases that were searched from 2020 to 2022 were Medline i.e., Scopus, Pubmed, Web of science and EBSCO.
Six articles were identified, involving 425 preterm infants. The included articles used different types of multimodal sensory stimulation in various combinations for improving neuromotor outcomes. All articles had a scoring of 6 or above in PEDro scale. This explains the good quality of articles. Early multimodal sensory stimulation improves neuromotor outcomes in preterm infants.

Keywords: Multimodal sensory stimulation, neuromotor outcomes, preterm/prematurity.

INTRODUCTION

World Health Organization defines preterm infants as babies who are born before the completion of 37th weeks of gestation. Globally, the rate of preterm birth is around 15 million/year. This shows increased trend in countries like India (World Health Organization, 2021). These infants suffer from various impairments especially neuromotor problems (Fawke, 2007).

Preterm infants are exposed to extra-uterine environment with excessive harmful light, noise ie., random types of excess stimulations before they are ready to face it (Jobe, 2014).

In intra-uterine environment, fetus undergoes a large amount of multimodal stimulation in various combinations, such as the auditory, tactile or vestibular stimulation. Brain development and maturation is conditioned by effects of these stimulations (Graven and Browne 2008; Sweeney *et al.*, 2010).

Current literatures explain the advantages of early multimodal stimulations and how motor experiences affect brain development and maturation. In addition, prematurity affects the ability to process received sensory information. This may impact motor, cognitive and sensory development (Symington and Pinelli 2006).

Early multimodal sensory stimulation can facilitate brain organization and reorganization, (Symington and Pinelli 2006) by using tactile, kinesthetic, visual, gustatory, vestibular, auditory and olfactory stimulations in multiple combinations (Graven and Browne 2008).

Systematic reviews that explain the effectiveness of multimodal sensory stimulation on neuro-motor development is sparse in preterm population (Machado *et al.*, 2017).

The aim of this systematic review was to evaluate and analyse the evidences on effectiveness of early multimodal sensory stimulation program in preterm infants, compared to other conventional therapies, to improve neuromotor outcomes.

MATERIAL AND METHODS

Inclusion criteria

Study type: Randomized controlled trial-RCT, published from 2016 to 2021.

Participants: Infants born alive before completion of 37 weeks of pregnancy.

Intervention: Early multimodal sensory stimulations in different combinations, compared to any conventional therapies.

Measurements and analysis: Motor, cognitive, visual, sensory and behaviour components of development.

Databases used for search from 2020-22:

1) Pubmed, 2) EBSCO, 3) Web of Science, 4) Scopus databases. Studies in English were included.

Terms and key words used for the search: *1) Multimodal sensory stimulation,* 2) *Sensory,* 3)

Multimodal sensory, 4) *Preterm infants*, 5) *Premature Infanst* in varied combinations of stimulations.

Screening of studies: From different databases listed above, articles were identified. They were reviewed by 2 independent authors. In the initial phase, duplicated articles were filtered out. Then, they were screened by their titles and abstracts to decide on their inclusion in this study. Re-evaluation of full-text of these RCTs was done. Then, the authors decided whether that RCT should be included in this review. If both of them disagree, another author was included in the process.

Articles included this systematic review were compared in terms of characteristics of subjects, intervention for both groups (type of intervention, frequency of treatment sessions and time), outcome measures used and results in analysis qualitatively.

Checking articles quality: Quality of every article included was assessed by PEDro measure. Scoring depended on the ten different criterias like randomization, blinding, data processing etc. Scoring ≥ 6/10 is considered as good (PEDro scale).

Risk of bias of each RCT was evaluated by Cochrane Handbook for Systematic Reviews. This consist of 5 components: bias arising from - randomization, deviations from proposed treatments, missing datas, outcome and selection of result to be reported. Each component was assigned a level of bias either low/ high risk or with some concerns (Cochrane).

The above processes were checked by two authors separately.

PRISMA guidelines were adopted for this systematic review.

RESULTS AND DISCUSSION

2808 studies were identified by electronic search. After removal of duplicates, 1453 studies remained. After title reading, 1355 studies were removed. Full text checking for fifty nine studies was done and 53 studies were removed.

Table 1: Articles description.

Article / year	Sample size/ Preterm(weeks)	Experimental and control group	Outcomes measured	Findings
Article -1 (Fontana *et al.*, 2020)	- EG[a] 27; CG[b] 30 - from 25 to 30 wks	EG[a]: 2 sessions of tactile stimulation, one session of visual stimulation / day. CG[b]: kangaroo mother care.	*Visual Functions*:	
			Spontaneous ocular movements with/ without target	p value 0.03
Article -2 (Zeraati *et al*., 2018)	-EG[a] 40; CG[b] 40 - from 32 to 36 wks	EG[a]: Auditorytactile Visual Vestibular[c]: 12 minutes for 5 sessions/week.(each type of stimulations for 3 minutes) CG[b]: conventional care.	*New Ballard scale*	Except scarf sign and square window all other components showed significant p value
Article -3 (Mohamed *et al*., 2018)	-EG[a] 20; CG[b] 20) -from 32 to 36 wks	EG[a]: tactile stimulation for10 minutes, oral stimulation for 15 minutes, kinaesthetic and vestibular stimulation for 5minutes, auditory stimulation during the treatment session: once for 2 wks. CG[b]: conventional care.	*Morgan scale*:	P value was significant for all components
			Brazelton scale	State regulation, Autonomic system, weight components showed no differences
Article -4 (Parashar and Samuel 2018)	-EG[a] 14; CG[b]14 -less than 37 wks	EG[a]: tactile stimulation and kinaesthetic stimulation - one session for 5 days. CG[b]: KMC and positioning.	Brazelton scale	No significant differences in hand to mouth component
Article- 5 (Carvajal *et al.*, 2019)	-EG[a] 29; CG[a] 2 - from 29 to 32 wks	EG[a]: Auditory and vestibular (15 minutes), tactile (10 minutes), Visual stimulus (always) - thrice daily. CG[b]: Same as above (but one session /day)	Improvement in birth Weight	p value around 0.04.
			Bradycardia	No significant difference
Article -6 (Pineda *et al.*, 2021)	-EG[a] 24; CG[b] 28 -less than 32 wks	EG[a]: SENSE program (in varied frequencies every week), by mothers under supervision. CG[b]: conventional care.	NNNScale	No significant difference in all components
			Hammersmith scale	P value showed significance in all components

In all above RCTs, the multimodal stimulations was intiated in the neonatal ICU. The frequency, time, way and combination of application of each type of intervention was different, ranging from one to three weeks.

In control group, four studies applied standard conventional care, and three studies used KMC. One trial used multimodal sensory stimulation with reduced frequencies.

A. Methodological quality

Table 2: PEDro scores.

Article/ year	Eligibilty of article	Random/ concealed allocation	Baseline similarity	Sample /PT blinding	Evaluator blinding	Dropouts more than 20%	Intension to include for analysis	Analysis between groups
Article -1 (Fontana *et al.*, 2020)	1	1	1	0	1	1	1	1
Article -2 (Zeraati *et al.*, 2018)	1	1	1	0	1	1	1	1
Article -3 (Mohamed *et al.*, 2018)	1	1	1	0	Nil	1	1	1
Article -4 (Parashar and Samuel 2018)	1	1	1	0	0	1	1	1
Article- 5 (Carvajal *et al.*, 2019)	1	1	1	0	1	1	1	1
Article -6 (Pineda *et al.*, 2021)	1	1	1	0	1	0	0	1

Blinding of physiotherapists and samples was the main bias noted in the above articles.

Table 3: Level bias risk.

Articles/ Bias risk	Component 1	Component 2	Component 3	Component 4	Component 5
Article -1(Fontana *et al.*, 2020)	+	X	+	+	+
Article -2 (Zeraati *et al.*, 2018)	+	X	+	+	+
Article -3 (Mohamed *et al.*, 2018)	+	X	+	X	+
Article -4 (Parashar and Samuel 2018)	+	X	+	X	+
Article- 5 (Carvajal *et al.*, 2019)	+	X	+	+	+
Article -6 (Pineda *et al.*, 2021)	+	X	+	+	+

Risk level: + - Low, X - High, - - With concerns

Scientific evidence about early multimodal sensory stimulation in preterm groups is sparse.

This systematic review included a very few number of RCTs, with different modes of therapies. However, all RCTs have shown similar baseline characteristics in both experimental and control group, and all articles elaborate on therapies, scales and analysis.

Varied combinations of multimodal sensory stimulations were used, but the most common were auditory, visual, vestibular and tactile stimuli. Most repeated stimulation duration was 10–15 minutes, twice a day (Fontana *et al.*, 2020; Zeraati *et al.*, 2018; Mohamed *et al.*, 2018; Parashar and Samuel 2018; Carvajal *et al.*, 2019; Pineda *et al.*, 2021). All studies have shown improvement in neuromotor outcomes.

Limitations of this study is that only six articles have been included, samples studied is also small. Therefore, more studies are needed to be included.

CONCLUSION

Early multimodal sensory stimulation may improve neuromotor outcomes in preterm infants.

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How to cite this article: A. Rajarajeswari, P. Ramachandran, L.N. Padmasani and Sailakshmi Ganesan (2023). Effectiveness of Early Multimodal Sensory Stimulation on Neuro-Motor Outcomes in Preterm Infants: A Systematic Review. *Biological Forum – An International Journal*, *15*(5): 1705-1708.