



PLAY SKILLS AND DEVELOPMENTAL TRAJECTORY IN PRESCHOOL CHILDREN WITH MILD TO MODERATE AUTISM SPECTRUM DISORDERS

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ABSTRACT Autism Spectrum Disorder (ASD) is characterized by deficits in social interaction, impaired communication abilities, restricted and repetitive behaviors and reduced interest and engagement in social activities, all of which impact their developmental and play skills. The purpose of this study was to observe the play skills and developmental trajectory, as well as to explore their correlation, among children diagnosed with mild to moderate ASD.

The play abilities of twenty preschool children, with ages ranging from 2 to 6 years, who have been diagnosed with mild to moderate Autism Spectrum Disorder, were assessed using the Knox Preschool Play scale. The assessment of developmental trajectory was conducted utilizing the Ages & Stages Questionnaire-III (ASQIII). The relationship between them was examined through the application of the Pearson correlation test. The play skills affected to moderate level scores ranging from -0.47 to 0.75 out of maximum score 2 and the developmental domains such as communication, fine motor skills, problem solving abilities & personal social development showed moderate to severe involvement scoring between 8.75 to 28.36 out of maximum score of 60 in each domain.

Space and Material Management displayed a moderate level of impairment. There is a notable impairment in both participation and pretense/symbolic play. The impact on the development of personal social skills and problem-solving abilities was notable when compared to children with typical development. This suggests a deviation from the usual trajectory of overall development and play capabilities. Researchers have noted a moderate positive correlation between material management and the development of both fine motor skills and problem-solving ability. Participation has been observed to exhibit a similar correlation with fine motor skills. The significance of executive functions, planning, and fine motor development in the development of play skills is emphasized by these findings, suggesting the necessity of Occupational Therapy intervention for child development.

KEYWORDS : Play development, Developmental trajectory, typically developing children, ASD

INTRODUCTION

“I might hit developmental and societal milestones in a different order than my peers, but I am able to accomplish these small victories on my own time.”

- Haley Moss, Attorney, Activist for Autism

Autism Spectrum Disorder is a disorder that affects neurology and development of a child which impairs the child's ability to interact with each other, communicate, learn, and behave.

It is characterized by a shortage in social interaction, impaired communication skills, and restricted repetitive forms of behaviour and loss of social interest or activities, which affect their play development. There is no single cause known in Autism Spectrum Disorder. Given the intricate nature of the disorder, the variation in symptoms and severity suggests a multitude of potential causes. It is possible that both genetics and environment contribute to the outcome. Both genetic and non-genetic factors contribute to the aetiology of ASD.^[1]

Play is a major occupation of a child. Play is an important part of a child's development. It builds fine and gross motor skills, social skills, communication skills, language, thinking, problem solving skills and sensory integration. For many preschoolers with ASD, engaging in imaginative play and navigating social interactions becomes a nuanced endeavor.^[2]

Play, as a primary activity during childhood, possesses inherent value that surpasses mere skill acquisition. It is not solely regarded as a technique for occupational therapists to supervise skill-focused activities, but rather as a dynamic process driven by the children themselves. The involvement in tailored play activities that are structured and sensory-friendly can prove advantageous, as they cater to their specific needs and interests. The recognition and resolution of these obstacles are essential for fostering inclusive environments that cater to the specific needs of children diagnosed with autism.^[2]

Conducting the study is imperative due to the substantial impairments observed in children with autism spectrum disorder, including deficits in social and interpersonal interaction, language and non-verbal communication, abnormal behavior, and adaptive responses. The impairments have a direct influence on their involvement in play activities. Furthermore, there is a lack of literature that specifically examines play skills in children diagnosed with autism. In addition, there is a scarcity of literary evidence concerning the distinct developmental domains and their relationship with play abilities in children diagnosed with mild to moderate Autism Spectrum Disorder (ASD).

The study examining the correlation between play skills and developmental milestones has the potential to shape the therapeutic approach for children diagnosed with Autism. The purpose of this study is to acquire knowledge regarding the play skills and developmental abilities of preschool children with Autism.

The aim of the study was to assess the play capabilities and developmental advancements across different domains in preschool children with mild to moderate autism, while also identifying potential correlations between them. The aim was to assess the play development in children with mild-to-moderate autism through the Knox pre-school play scale. Additionally, the study aimed to explore different developmental aspects in children with mild to moderate Autism, employing the Ages and Stages Questionnaire (ASQ-III). Furthermore, the research sought to investigate the correlation between play development in children with mild to moderate ASD and their overall developmental progress.

The study included children between the ages of 2 and 6 who were referred to the Occupational Therapy department and scored between 70 and 153 on the Indian Scale for Assessment of Autism (ISAA). Participants who had prior diagnoses of cognitive, motor, mental, cardiovascular, or other neurological impairments were excluded from

the study. The study utilized a cross-sectional and correlational research design and was carried out within the Occupational Therapy department of a tertiary care hospital in a metropolitan city. The purposive sampling method was used, with sample size of thirty children based on the departmental workload. The details as follows

Approval was obtained from the departmental review board for the study. The study adhered to the Helsinki guidelines for ethical considerations. The Ages & Stages questionnaire III (ASQIII) was translated in Marathi & Hindi. The validity was assessed. The children who were diagnosed with Autism Spectrum Disorder (ASD) underwent a screening process to establish their eligibility. Ultimately, 25 children met the inclusion criteria and were included in the study. Furthermore, the parents were provided with the patient information sheet to guarantee their awareness. They were provided with the ASQIII assessment, according to their preferred language. A total of 20 parents successfully filled out the questionnaire. ASQ III studies the development of the child in different fields such as communication skills, fine motor skills, gross motor skills, problem solving abilities and personal social. Each component has sub questions and each item is scored as 'Yes' = 10, 'Sometimes' = 5, 'Not Yet' = 0. Each sub-question score is added to get a final score for the respective component.^[3,4]

The research team members evaluated the children's play skills using the Knox preschool play assessment, with the team members themselves participating in the play activities.

The children were rated as per their observed play skills. Knox preschool Play scale, analyzes four dimensions of play, including space management, material management, pretense/ symbolic and participation.^[5,6] The scoring of the scale is from -1 to 2 indicates a: -1 lack of ability to perform aptly in that component and 2 good performance ability in that component.

The scores for both the assessment tools were recorded on the datasheet by the team members.

The data analysis encompassed the usage of mean scores for play skills and developmental scores across diverse age groups, alongside the application of Pearson correlation.

RESULTS

Table 1 : Population Table: Demographic Data Of Children With Mild To Moderate Autism Included In Our Study

Age range	Males	Females
30-36 month	2	0
37-48 month	5	2
49-60 month	9	2
Total	16	4

A strong male bias in autism spectrum disorder (ASD) prevalence has been observed with striking consistency

Table 2 : Mean Value Of Knox Pre-school Play Scale Components In Children With Mild To Moderate ASD

Age -	Space management (range score - 1 to 2)		Material Management (range score - 1 to 2)		pretence/ Symbolic (range score - 1 to 2)		Participation (range score - 1 to 2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
30-36 month	0.75	1.06	0.75	0	-0.75	0.35	0	1.06
37-48 month	0.50	1.04	-0.03	0.74	-0.78	0.26	-0.60	0.27
49-60 month	0.72	0.68	0.47	0.74	-0.50	0.50	-0.47	0.54

In space management, children exhibit near normal play skills in the developmental stages of 30-36 month, 37-48 months and 49-60 months have near normal play skills in space management. We observe moderately affected play skills in the 37-48 month and 49-60 month stages for material management. The developmental stage of 30-36 months shows a moderate challenge in task participation, while the other two groups experience a severe challenge.

As seen in the Table 3 Communication skills were more affected as age advanced. The children in the age group of 37-48 months showed severely affected fine motor skills & problem solving abilities .

Personal social development was severely affected at 30-48 months & moderately improved at 40-60 months.

Table 3 : Mean Value Of ASQIII Components In Children With Mild To Moderate ASD

AGE	Communication (Mean value Out of 60)	Gross Motor (Mean value Out of 60)	Fine Motor (Mean value Out of 60)	Problem Solving (Mean value Out of 60)	Personal Social (Mean value Out of 60)
30-36 month	32.5	45	37.5	22.5	15
37-48 month	25	36.2	8.75	18.75	13.7
49-60 month	23.80	37.14	18.39	26.99	28.36

We analysed the correlation between the play skills & the developmental domains in these age groups as follows

Table 4: Correlation Between Values Obtained On Knox Pre-School Play Scale And ASQIII In Children With Mild To Moderate ASD

Correlation	R value	P value	Significance
Space management v/s Communication	-0.18	0.43	NS
Space management v/s gross motor	-0.23	0.31	NS
Space management v/s fine motor	0.23	0.32	NS
Space management v/s Problem solving	0.39	0.08	NS
Space management v/s Personal social	0.20	0.38	NS
Material management v/s communication	-0.069	0.77	NS
Material management v/s gross motor	-0.136	0.56	NS
Material management v/s fine motor	0.469	0.03	Sig (0.05)
Material management v/s Problem solving	0.457	0.04	Sig (0.05)
Material management v/s personal social	0.411	0.07	NS
Pretense/Symbolic v/s communication	0.04	0.85	NS
Pretense / symbolic v/s gross motor	-0.15	0.513	NS
Pretense / symbolic v/s fine motor	0.18	0.441	NS
Pretense / symbolic v/s Problem solving	0.12	0.58	NS
Pretense / symbolic v/s Personal social	0.37	0.10	NS
Participation v/s communication	0.06	0.77	NS
Participation v/s gross motor	0.31	0.17	NS
Participation v/s fine motor	0.45	0.04	Sig (0.05)
Participation v/s. problem solving	0.20	0.38	NS
Participation v/s Personal social	0.15	0.51	NS

It shows moderately positive correlation between Material management v/s fine motor, Material management v/s Problem solving and Participation v/s fine motor at 95% level of significance

DISCUSSION

In the current study, play abilities and development of preschool children with mild to moderate autism was assessed. The data in the present study corroborates our findings that the development and play of a child does not progress at a normative rate.

According to the data presented in Table (2), our observations indicate that space management exhibits a slight decline across all age groups in comparison to typically developing children.

Problem-solving and decision-making skills are impaired in children with autism. In the study 'Autism Develop Planning and Organizational Skills'^[7] it is stated that difficulties arise from challenges in flexible thinking, planning, organizing, considering multiple perspectives, and generating alternative solutions.

As demonstrated in previous research, children with ASD face challenges in their ability to explore and comprehend object

relationships, which in turn affects their executive functioning and spatial management abilities. Wilson et al. (2017) conducted a study titled "Object play in infants with autism spectrum disorder: A longitudinal retrospective video analysis"^[8]. Through the exploration of objects, infants develop an understanding of their interrelationships, leading to the transition into relational play (Williams, 2003). Thus, children find it difficult in managing and organizing space. In the study titled "Moving toward understanding autism: visual motor integration, imitation and social skill development"^[9], it was noted that children diagnosed with Autism Spectrum Disorder (ASD) exhibited challenges in spatial navigation.

Based on the data presented in Table 2, our observations indicate that material management shows a moderate impairment in the 37 to 48 months age group when compared to typically developing children. This is characterized by decreased motor anticipatory responses and performance, which may consequently result in difficulties in material management. Children diagnosed with ASD demonstrate stereotypic behaviors, including repetitive mannerisms and fidgeting, which hinder their ability to effectively utilize the materials in front of them. Moreover, there can be challenges in executive function, encompassing tasks such as organization, planning, prioritization, and self-monitoring. Furthermore, in the study conducted by Alexander Luria et al.^[10], it was observed that children diagnosed with ASD display symptoms of frontal lobe syndrome, such as disinhibition, impaired sequential instruction comprehension, and repetitive motor behaviours. Children acquire a comprehension of the world by engaging in pretense and symbolic play, as well as by developing the capacity to discern and differentiate between reality and fantasy. There was a decrease in participation observed during parallel play and children displayed a preference for solitary play. Our findings indicate that symbolic play exhibits a moderate level of impairment across all age groups when compared to typically developing children who do not engage in pretend play. As stated in the research on Social Play and Autistic Spectrum Disorders^[11], children diagnosed with ASDs exhibit the ability to engage in pretend play under highly structured circumstances or when prompted. The play behaviour of children with autism often lacks the necessary engagement in symbolic play, as it tends to be passive rather than genuinely interactive. In a scholarly investigation conducted by Kaitlyn P. Wilson et al.^[8], in the words of Atlas (1990), it is noted that pretend play in autism is often characterized by rigidity and stereotypy, a typical feature among children with ASDs. This is not merely an idiosyncrasy of play, but rather a manifestation of difficulties in executive functioning, resulting in challenges in engaging in pretend play.

Children within the age range of 2-6 years tend to exhibit a higher inclination towards parallel play rather than participatory play. In our study, we observed that when the therapists were included as team members in play, there was a notable increase in the children's interest in parallel play compared to participatory play. Furthermore, in Lauren's^[12] study, which aimed to identify dimensions of activity participation among children with autism, it was observed by the authors that the primary hindrance to engaging in physical activity is the absence of supportive or active friends, as noted by the main facilitators. The findings of our study indicate that the children displayed a deficiency in their ability to actively participate in social interactions with their peers. The findings have significant implications for the classification of activities for children with ASD, as they indicate that the frequency of specific activities can be influenced by child characteristics. According to a study conducted by Jennifer et al.^[13], the findings revealed that children with ASD exhibit cognitive and emotional empathy, which may hinder their social and emotional reciprocity, potentially limiting their participation in play.

Based on our analysis in table (3), it is evident that communication is moderately impacted across all age groups when compared to typically developing children. Children aged 48-60 months encountered greater communication difficulties as a result of inflexible behaviour and limited engagement in parallel play, often favouring solitary play. According to the study on the assessment of social skills in children with autism during free-play situations^[14], it was found that learning takes place through modelling, imitation, and observation. Children diagnosed with ASD often miss out on this opportunity due to their tendency to engage in more verbal interaction with adults rather than peers, especially in mainstream settings. The study conducted by Alderson Day B^[15] revealed that these children primarily rely on visual thinking rather than verbal communication, leading to difficulties in their ability to communicate effectively.

The gross motor scores are average in all age groups. Minimal delay is noted in 42-47 and 48-60 months age group as compared to typically developing children, this may be due to children being provided less opportunities to deal with objects and also, they are not socially active. Furthermore, the study on the correlation between Gross Motor Impairment and Social Skills in ASD^[16] reveals that children's gross motor ability significantly affects their social experiences and interactions. There exists a considerable body of literature on motor development in ASD, that highlights a deficiency in gross motor skills among individuals with autism. Studies have indicated a link between this variable and diminished interpersonal coordination as well as decreased involvement in social activities among children and adolescents.

Our observations have revealed that individuals between the ages of 36 and 41 months display a mild level of impairment in fine motor skills. Children aged 42-47 months and 48-60 months exhibit significant impairments in comparison to their typically developing peers. The study titled "A Comparative Analysis of Motor Performance, Praxis, Coordination, and Interpersonal Synchrony in Children with and without Autism Spectrum Disorder"^[17] offers an explanation for this phenomenon by attributing it to insufficient connectivity among cortico-cortical structures and cortico-cerebellar and cortico-striatal structures in children with ASD. The involvement in fine motor activities necessitates heightened cortical connections, which could be deficient in children with ASD. This finding is further corroborated by a study investigating the developmental trajectory of children with and without ASD^[18], which suggests that an impairment in the normal mechanism of synaptic plasticity could potentially result in motor delay. Based on our observations, it has become apparent that the children lack social interaction and, as a result, do not have sufficient opportunities to engage in activities. Furthermore, the parents do not anticipate their involvement in Activities of Daily Living, which subsequently hinders fine motor skills.

In all the age groups of 36-41 and 48-60 months, the problem solving is moderately impaired as compared to typically developing children. 42-47 month children show severe impairment in their problem solving abilities as compared to typically developing children. Furthermore, the study which examined stress signalling pathways that have a detrimental impact on the structure and function of the prefrontal cortex^[19], stated that this could be attributed to a dysfunction in the prefrontal cortex, primarily impacting higher cognitive processes such as decision-making and future planning and organization. In the scholarly investigation conducted by Rebecca J Landau and her fellow researchers^[18] found that the compromised synaptic plasticity and the struggle to maintain accuracy in complex praxis tasks that necessitate speed and precision contribute to difficulties in problem-solving in children with ASD.

Our study revealed a notable decline in personal social development across nearly all age groups, when compared to children who typically develop. Anderson et al. (2004)^[14] conducted a study on the social skills assessment of children with autism in free-play situations. The study found that cooperative play was not observed among kindergarten and primary school children with ASD when interacting with their peers. Children diagnosed with ASD exhibited a preference for solitary play rather than engaging in interactive group play, which aligns with our observation and can be attributed to communication challenges. Consequently, the child's personal social development is compromised.

When the correlation between different component of play scales and ASQ was observed. as seen in Table 4, Material management v/s fine motor, Material management v/s Problem solving and Participation v/s fine motor could establish moderately positive, but statistically significant correlation ($P < 0.05$) was established.

Based on our analysis, there is a clear positive correlation between Material Management and Fine Motor. In the study examined the correlation between motor development and social adaptability in individuals with autism spectrum disorder^[20], the results indicated that fine motor skills were more closely associated with certain social skills compared to gross motor skills. These activities primarily engage smaller muscle groups, such as those in the hands and fingers, and encompass tasks such as using utensils, finger-painting, cutting with scissors, writing, and handling materials. Thus there is a strong correlation between motor skills and social function, resulting in improved material management.

On observing the correlation Material Management V/S Problem solving, we glean that the correlation obtained is affirmative. The correlation obtained was moderate positive with statistical significant results. According to Eyüp Yılmaz and Mark D. Griffiths' systematic review^[21], playing games that involve effective material management is highlighted as a crucial activity for children to enhance their social problem-solving (SPS) abilities. Our study also confirms this finding. The study conducted by Shweta Kailiani et al. examines the importance of considering flexibility and effectiveness when evaluating problem-solving skills. The significance of flexibility in material management abilities has also been highlighted in previous studies. The significance of flexibility lies in its capacity to generate a multitude of distinct solutions to a problem. A symbiotic relationship can be observed between material management and problem solving, as both require flexibility, indicating a positive correlation. The findings of our study indicate that children diagnosed with ASD showed moderate impairments in material management and a similar pattern of development in problem-solving ability.

Our study revealed that participation and fine motor development show moderate positive correlation at 95% level of significance. Within the study titled "The Relationship Between Motor Development and Social Adaptability in Autism Spectrum Disorder"^[20], it was observed that fine motor skills exhibited a stronger correlation with certain aspects of social adaptability, as opposed to gross motor skills. This finding aligns with previous research conducted on typically developing children. Research has revealed a correlation between fine motor functioning and various cognitive factors in children with ASD, including visuospatial cognition, object exploration, social orientation, and language development. In addition, the acquisition of fine motor skills plays a crucial role in enabling preschool students to effectively engage with their physical and social surroundings, which in turn enhances their visuospatial cognition and contributes to the development of language abilities. In their study, Children with ASD showed deficits in visual spatial cognition, social orientation & object exploration leading to fine motor deficits, thus affecting the play participation.^[20] The importance of fine motor skills lies in their close relationship with social skills, while fine motor skills directly impact an individual's ability to perform essential activities. Challenges in fine motor skills have an impact on an individual's capacity for self-care. Consequently, this has an impact on the engagement in recreational activities.

According to our data, play development in children with ASD is impacted, resulting in impairment in areas such as pretense/symbolic play, personal social skills, fine motor development, and problem-solving abilities. Consequently, we can hypothesize that children with ASD display an impairment in play development in contrast to typically developing children. Children with Autism Spectrum Disorder (ASD) exhibited lower scores in comparison to typically developing children across various developmental domains, including communication skills, fine motor skills, problem-solving abilities, and personal-social functioning. Hence, a hypothesis can be made that children with ASD demonstrate hindered developmental progress when compared to typically developing children.

This study has considered the direct observation of play development through active participation of the research team members in play. Play is the major occupation of a child. We tried to establish correlation between play and developmental trajectory. A larger sample size may give us predictive results. This study also considered Parents observation about their child's development. But we did not consider the sensory issues & exposure to preschool environment in children with ASD. The consideration of sociocultural and environmental exposure's impact was not possible. These shortcomings can be overcome by larger sample size, use of objective socioeconomic scale & more objective developmental assessment administered by the therapists.

CONCLUSION

Anita Bundy (1993) was the one who proposed that occupational therapists are unique in their perspective of play as an occupation. They use play as a tool to create therapeutic situations in which their clients can try out new behaviours and skills with fewer risks and consequences for failure than would normally exist in the clients' daily lives. Thus, occupational therapists "make a living by creating 'play' and by enabling others to play"

Material Management, pretense/ Symbolic and Participation. The assessment indicates mild to moderate impairment in Space Management and Material Management, possibly resulting from a deficiency in flexible thinking and planning abilities.

These findings collectively point to a considerable impediment in all the domains of play in children with mild to moderate ASD, whereas the impact is more pronounced in participation and pretense symbolic play and material management as compared to typically developing children. It has been observed that children diagnosed with mild to moderate ASD experience a greater impact on their personal social skills and problem-solving abilities in comparison to typically developing children. This suggests a divergence from the usual trajectory of overall development when contrasted with a child experiencing typical developmental patterns.

Both the scale together indicated that the overall development of the children with mild to moderate ASD affects the acquisition of the age appropriate play skills. This sets the paradigm for Occupational therapy treatment which employs play as the means to an end for the development of the child.

REFERENCES

- Hopkins HL, Smith HD. Willard and Spackman;s Occupational Therapy USA: 8th edition. Lippincott Williams and Wilkins; 1993.
- Trigg, Diane Parham and Fazio, Linda S. Play in Occupational Therapy for Children. s.l. : Mosby, 2007. 9780323029544.
- Squires, Jane and Bricker, Diane. Ages & Stages Questionnaire A Parent -Completed Child Monitoring System. s.l. : Paul H. Brookes Publishing Co., 2009. 978-1-59857-041-0.
- Velikonja T, Edbrooke-Childs J, Calderon A, Slead M, Brown A, Deighton J. The psychometric properties of the Ages & Stages Questionnaires for ages 2-2.5: a systematic review. Child Care Health Dev. 2017 Jan;43(1):1-17.
- Knox, S. (1974). A play scale. In M. Reilly (Ed.), Play as exploratory learning (pp. 247-266). Beverly Hills, CA: Sage.
- Sposito AMP, Santos JLF, Pfeifer LI. Validation of the Revised Knox Preschool Play Scale for the Brazilian Population. Occup Ther Int. 2019 May 2;2019:6397425.
- Wolmark, Mark. 2023. Golden Steps ABA. Autism Develop Planning and Organizational Skills(Online) december 5, 2023. <https://www.goldenstepsaba.com/resources/autism-develop-planning-and-organizational-skills>
- Wilson Kp, Carter, Mw, Wiener HL, DeRamus ML, Bulluck C, Watson LR, et al. Object play in infants with autism spectrum disorder: A longitudinal retrospective video analysis. Autism; developmental language impairments. 2017 June; 2.
- Lidstone E, Mostofsky H. Moving Toward Understanding Autism: Visual-Motor Integration, Imitation, and Social Skill Development. Pediatric Neurology. 2021 September; 122:98-105.
- Demetriou, Eleni A, DeMayo, Marilena M and Guastella,Adam J(2019)Executive Function in Autism Spectrum Disorder: History, Theoretical Models, Empirical Findings, and Potential as an Endophenotype. Switzerland : Frontiers in psychiatry, Vol. 10.2019 Nov 11:10:753. doi: 10.3389/fpsy.2019.00753. eCollection 2019.
- Jordan. Social play and autistic spectrum disorders: a perspective on theory, implications and educational approaches. Autism : the international journal of research and practice. 2003 December; 7(4): 347-360.
- Little M, Sideris J, Ausderau , Baranek G. Activity participation among children with autism spectrum disorder. The American journal of occupational therapy : official publication of the American Occupational Therapy Association. 2014 March -April; 68(2): 177-185.
- Quinde-Zibut MJ, Williams Z, Gerdes , Mash E, Heflin , Cascio C. Multifaceted empathy differences in children and adults with autism. Scientific reports. 2021 September; 11(1).2021; 11: 19503. doi: 10.1038/s41598-021-98516-5
- Anderson A, Moore, D, Godfrey R, Fletcher-Flinn M. Social skills assessment of children with autism in free-play situations. Autism : the international journal of research and practice. 2004 December; 8(4): 369-385.
- Alderson-Day B. Verbal problem-solving difficulties in autism spectrum disorders and atypical language development. Autism research : official journal of the International Society for Autism. 2014 October; 7(6): 720-30.
- Wang LAL, Petrulla V, Zampella CJ, Waller R, Schultz RT. Gross motor impairment and its relation to social skills in autism spectrum disorder: A systematic review and two meta-analyses. Psychol Bull. 2022 Mar-Apr;148(3-4):273-300.
- Kaur , Srinivasan S, Bhat. Comparing motor performance, praxis, coordination, and interpersonal synchrony between children with and without Autism Spectrum Disorder (ASD). Res Dev Disability. 2018 January; 72: 79-95.
- Landa R, Gross A, Stuart A, Faherty. Developmental trajectories in children with and without autism spectrum disorders: the first 3 years. Child development. 2013 March-April; 84(2): 429-442.
- Armsten A. F. (2009). Stress signalling pathways that impair prefrontal cortex structure and function. Nature reviews. Neuroscience, 10(6), 410-422.
- Chen Y, Fei X, Wu T, Li H, Xiong N, Shen R, et al. The relationship between motor development and social adaptability in autism spectrum disorder. Frontiers in psychiatry. 2022 November; 13. 2022; 13: 1044848. doi: 10.3389/fpsy.2022.1044848
- Yılmaz, E., Griffiths, M.D. Children's social problem-solving skills in playing videogames and traditional games: A systematic review. Educ Inf Technol 28, 11679-11712 (2023).

Knox preschool play scale has four component Space management,