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"PREVALENCE OF ACTIVE PRIMITIVE REFLEXES AND ITS IMPACT ON MOTOR SKILLS AND SENSORY PROCESSING IN PRESCHOOL CHILDREN."

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Abstract:

Background: Primitive reflexes are automatic responses to specific stimuli and are inhibited as the central nervous system matures. The active primitive reflexes(APRs) in preschool children indicate disturbance involving difficulties in social, educational, developmental problems, difficulties in learning, coordination, and attention. Nowadays, many children have delays/deficiencies in reaching milestones and are not able to perform activities in school, and also have reduced ability to process motor and sensory information. Therefore, early evaluation of primary reflexes in preschool children is required.

Aim and objectives: To identify the prevalence of active primitive reflexes and it impact on motor skills and sensory processing in preschool children.

Method: 107 preschool children (4–6 years old) from schools of Bardoli were checked for the presence of the asymmetric tonic neck reflex, symmetric tonic neck reflex, tonic labyrinthine reflex, Palmer, Galant, and Moro reflex. Motor skills were checked with the motor proficiency test(4–6) and sensory performance with sensory profile 2.

Result: over half (86%) of preschoolers survived at primitive reflex levels. Statistical analysis was performed by SPSS Spearman correlation. The inverse correlation between reflex test scores and MOT 4–6. The sensory profile analysis indicated that the levels of reflex activity were most closely related to sensory impairments.

Conclusion: The relationship between APR and motor skills suggests that APR can affect the motor skills of preschool children, and APR with sensory profile indicates that examination of the child's primary reflexes is a good screening tool to determine a child's development.

Keywords: Primitive reflexes; Preschool children; Motor skills; Sensory profile; Physical development.

Introduction

Preschoolers may have different motor and sensory development [1]. One is the primary reflex, which is stereotypical, and the brainstem's involuntary motor and sensory output [2]. They develop during prenatal life and strengthen postnatally [3]. After completing their function, they are integrated and replaced by more mature postural reactions [4]. The presence of an active primary reflex known as the "persistent primary reflex" (PPR) [2] is considered indicative of neurological dysfunction and negatively affect a child's functioning [5].

Intensive psychomotor development occurs in the first year of life, which can lead to sensory-motor problems that persist with age [6]. Parents and educators often notice these impairments [7]. The development of motor and sensory skills in children can affect due to active reflexes, which are unintegrated with the previous and subsequent activity [8]. If reflexes are not combined, they will continue to be aroused by a similar stimulant that is not as strong as in an infant. Therefore reflex integration is crucial for the growth of children [9].

After entering preschool duration, children continue to develop their motor and sensory development and acquire new skills like jumping, ball playing, cycling, and playing with ladders and sliders. APR affects the quality of children's motor and sensory abilities. Therefore, delayed responses are associated with delayed/deficiencies in reaching milestones and reduced ability to process information [10].

Primary reflexes include the Asymmetrical tonic neck reflex (ATNR), the Symmetrical tonic neck reflex (STNR), the Tonic labyrinthine reflex (TLR), the Galant reflex, the Palmer reflex, and the Moro reflex.

The **ATNR** is developed at 18 weeks of fetal life and disappears between 3 to 6 months after birth [1]. It is responsible for muscle tone, hemisphere domination, binocular vision, hearing, and eye-hand coordination. Preserved ATNR can cause difficulty in rolling, crawling, crossing the midline, objects manipulation, visual perception, and improper posture during walking [9]. The **STNR** is developed between 6 to 8 months after birth and consolidates between 9 to 11 months after birth. Children with preserved STNR may forget/clumsily crawl, have an improper body holding, sloping shoulders, walk on their fingers, constant swaying, movement when sitting, reliance on the table, have attention and concentration problems, reading-writing difficulties, poor memory, and clumsiness. [11].

The **TLR** reflex occurs at 16 weeks in utero, should be consolidated at 4 months postnatally, and progress to integration up to 3 years after birth. If it lingers, it can lead to poor balance, muscle tone, and eye movement control, which can lead to further difficulties in information processing [12]. The **Galant reflex** develops in the womb at 20 weeks and is integrated at 3 to 9 months after birth. It can lead to difficulty with attention, concentration, constant sitting, bedwetting, scoliosis, hyperactivity, postural problems, slow speech development, grammar-spelling, and problems walking and performing complex leg movements. [13].

The **Palmer reflex** is formed at birth and disappears after 4 to 6 months. If not integrated, it may lead to difficulty in grasping objects and awkward pencil gripping. The **Moro reflex** forms at 28 weeks and is integrated at 5 to 6 months. If it persists, it can lead to hypersensitivity,

inappropriate reactions, difficulty concentrating, mood swings, behavior changes, visual problems, and learning difficulties [11] and decrease learning and memory abilities.

A **motor proficiency test** (MOT 4-6) assess motor function in preschool children. It includes 18 items which measure fine and gross motor function[14] and the **Toddler Sensory Profile**(SP-2) is a clinical tool for assess sensory skills in children. It provides information about a child's processing patterns, which used for inform goal-setting and intervention planning. Parents/caregivers and/or teachers fill out forms to obtain information about a child's response to sensory events [15], [16].

The primary research question is if there is a correlation between reflex activity and motor-sensory functions. The following hypotheses were tested: the presence of APR is associated with decreased motor and sensory skills.

Nowadays, many children have delays/deficiencies in reaching milestones, are not able to perform activities in school, and also reduced ability to process motor and sensory information. Therefore, early screening is required to know their effects on motor skills and sensory processing.
So the ultimate aim is to investigate the prevalence of APR and its effect on preschool children's motor skills and sensory issues noticed by parents.

Methods:

Study Design and Population:

A cross-sectional observational study was conducted on preschool children aged 4 to 6 from different schools in Bardoli. Parents/teacher were informed about the study purpose and process. Children who were ready to volunteer for the study were included according to the inclusion and exclusion criteria, then informed consent was obtained from parents, and information questionnaires were filled out by parents.

Table 3.10.1: **Characteristics of the participants.**

Parameter	4 years	5 years	6 years
Age [mean ± SD (years)]	4.57± 0.070	5.38 ± 0.038	6.16 ± 0.103
Girls [N]	14	26	11
Boys [N]	10	35	17
BMI [mean ± SD (kg/m²)]	12.87 ± 1.47	14.15 ± 2.04	14.121.86

Study setting:

We were approached for many schools in Bardoli, Gujarat but out of that 3 schools were ready to voluntarily part in our study. Data were collected from March 2022 to March 2023 from junior and senior KG students with convenient sampling.

Data were collected from private schools of Bardoli where children come from urban and/ or rural areas, and it was done by the physical therapist who was pursuing a master's in neurological science.

Preschool children from age 4 to 6 years old, girls and boys, were included, and those with any neurological conditions like CP, ADHD; musculoskeletal conditions; non-consent by parents, and non-cooperative children were excluded from the study.

Motor proficiency test (MOT 4-6) and sensory profile 2.0(SP2) were used as outcome measures.

Procedure:

The study was done to test the integration of reflexes during extension and flexion variants for ATNR, STNR, TLR, Galant, Palmer, Moro, and MOT 4–6 and sensory profile 2.0. Each reflex was examined up to 5 times to obtain the best positive answers.

- **Assessment of Reflex Activity**

ATNR and STNR were tested in the four-point knee position with the head in the middle. During the ATNR, rotation of the head to the right or left is observed in changes in the body with the movements of the trunk and pelvis.

The scoring of ATNR was as followed:

0. No movement of the opposite arm, shoulder, or hip (no reflex occurs);

1. A slight deflection of the opposite arm or movement of the shoulder or hip (reflex present in 25%);

2. Clear deflection of the opposite arm with or without involving the shoulder or hip (reflex present in 50%);

3. Significant deflection of the opposite arm with or without involving the shoulder or hip (reflex present more than 50%);

4. Descent of the opposite arm as a result of the rotation of the head. Uncontrolled hip movement can also occur (reflex survived 100% on the facial side).

Figure 3.10.1: Position for the examination of ATNR for the right side.

Figure 3.10.2: Position for the examination of ATNR for the left side.

The STNR was tested in two variants: when the child's head was extended, symptoms such as extending upper limbs, sitting on the heels, or trunk movements were observed, and when the child's head was flexed, elbows were bent, pelvis lifted, or knees extended. The therapist also assessed the intensity of current compensations.

The scoring of STNR was as followed:

0. No reaction;

1. Shaking of one or two arms or minimal movement of the trunk;

2. Elbow movement and/or hips or bending of the spine;

3. Deflection of the arms when lowering the head and spontaneous straightening of the hands when lifting the head;

4. Bending arms or going back to sitting on the heels.

Figure 3.10.3: Position for the examination of STNR extension.

Figure 3.10.4: Position for the examination of STNR flexion.

The TLR measurement was taken while standing position with feet on hips and hands-on body. Children were asked to close their eyes like ATNR and STNR. For TLR extension, Compensations including hand or UE movements, standing on toes, and disturbance/loss of balance were observed, and fist holding, knee deflection, and disturbances/ loss of balance for TLR flexion.

The scoring of TLR was as followed:

0. No reaction;

1. Minimal balance disturbances whilst changing head position;

2. Balance disturbances during the test and/or muscle tone change;

3. The child almost loses balance and/or shows disorientation after the task;

4. Loss of balance and/or significant muscle tone change whilst attempting balance stabilization. Dizziness and nausea may occur.

Figure 3.10.5: Position for the examination of TLR extension.

Figure 3.10.6: Position for the examination of TLR flexion.

The Palmar grasp was caused by skin irritation. It was bought on by applying submaximal pressure with a spatula to the palm.

The scoring of the palmar reflex was as followed:

0. Lack of reflex,

1. Low activity,

2. Medium activity,

3. High activity,

4. Maximum activity.

Figure 3.10.7: Position for the examination of Palmar reflex.

A Galant reflex was observed by drawing a vertical line with the thumb along the thoracic and lumber region. After stimulation, the movement was present at the stimulation side (children could scratch the affected area).

The scoring of the Galant reflex was as followed:

0. No reaction;

1. On the stimulated side, outward hip movements occur at 15°, with the possible hypersensitivity and tickling sensation;

2. On the stimulated side, outward hip movements occur at 30°, with the possible hypersensitivity and tickling sensation;

3. On the stimulated side, outward hip movements occur at 45°, with the possible hypersensitivity and tickling sensation;

4. On the stimulated side, outward hip movements occur at 45°, thereby affecting the child's balance with the possible hypersensitivity and tickling sensation.

Figure 3.10.8: Position for the examination of Galant reflex.

The Moro reflex was tested by turning the back of the assistant's arm and tilting the head back. Wait for whether the child bends his knees, pulls his arms out of the way, maintains the movement during the backing up, or makes other hand movements. It was recommended to close the eyes beginning while heading Movements.

The scoring of Moro reflexes was as followed:

0. No reaction (arm will remain in starting position);

1. Slight movement of the arms outside and/or redness of the skin;

2. A definite partial abduction of the arms and an intake of breath and/or a little reluctance to take part in the test, difficulty falling backward;

3. 75% abduction of arm and/or the participant is shaken by the test procedure and/or holding his/her breathe, skin redness, or pallor;

4. Full abduction of arm and/or very significant irritation during the test procedure, possible screaming, significant resistance to test, or anxiety.

Figure 3.10.9: Position for the examination of Moro reflex.

APRs have fully integrated into the child's central nervous system, leading to no reaction. The reflex activity level was determined based on compensatory movements, emotional reactions, and changes in breathing patterns, grimaces, or the pout of lips.

The lower the reflex integration, the higher the score. The maximum score was 40 points was converted into reflex activity level on a scale of 0 to 4.

Table 3.10.2: **The degree of primitive reflex integration scale**

Final scores in APR examination	Level of reflex activity
0-3	0- No activity
4-15	1- Low
16-25	2- Medium
26-35	3- High
36-40	4- Max

- **Motor Proficiency Test (MOT) Assessment**

The MOT 4–6 involved 18 items with a high-performance rating. It requires children to have good balance, cooperation, and concentration and is easy to repeat, evaluate, challenge preschoolers' skills, and show their physical strength. These activities were classified into four types of performance: (a) stability, (b) locomotion, (c) object control, and (d) fine movement skills.

Description of Items -

0. Forward jump in a hoop 1. Forward balance (b) 2. Placing dots on a sheet (d) 3. Grasping a tissue with toes (d) 4. Sideward jump (b) 5. Catching a stick (c) 6. Carrying balls from one box to another (b, c) 7. Reverse balance (b) 8. Throwing at a target disk (c) 9. Collecting matches (d) 10. Passing through a hoop (a, b) 11. Jumping in a hoop on 1 foot, standing on 1 leg (a, b) 12. Catching a tennis ring (c) 13. Jumping jacks (b) 14. Jumping over the cord (b) 15. Rolling around the long axis of the body (a, b) 16. Standing up while holding a ball on the head (b, c) 17. Jumping and turning in a hoop (a, b).

The test was graded on a three-point scale, showing 0 mean not completed, 1 mean completed 50% of the child's capacity, and 2 mean fully mastered. This question contains a total of 34 points. The higher the scores, the higher the skill. The points were converted to a five-point scale describing child development accelerated (4), very good (3), normal (2), delayed (1), or altered (0). Each activity was examined 3 times to obtain the best positive answers.

Table 3.10.2: **The MOT test range scale**

Final scores in APR examination	Level of reflex activity
0-8	0- Altered
9-15	1- Delated
16-25	2- Normal
26-29	3- Very good
30-34	4- Accelerated

- **Sensory Processing Assessment**

For the sensory processing assessment, we used the sensory profile 2.0 scale. [Annexure 8] Parents answered questions about the presence or lack of appropriately described behavior, and the sum of the scores obtained in each subgroup was calculated. The results were presented as percentages.

The score was based on 1 – almost never (10% or less), 2 – occasionally (25%), 3 – half of the time (50%), 4 – frequently (75%), and 5 –almost always (90 % or more). It was given information about if the child was a seeker, avoider, sensitive, or bystander.

Statistical analysis

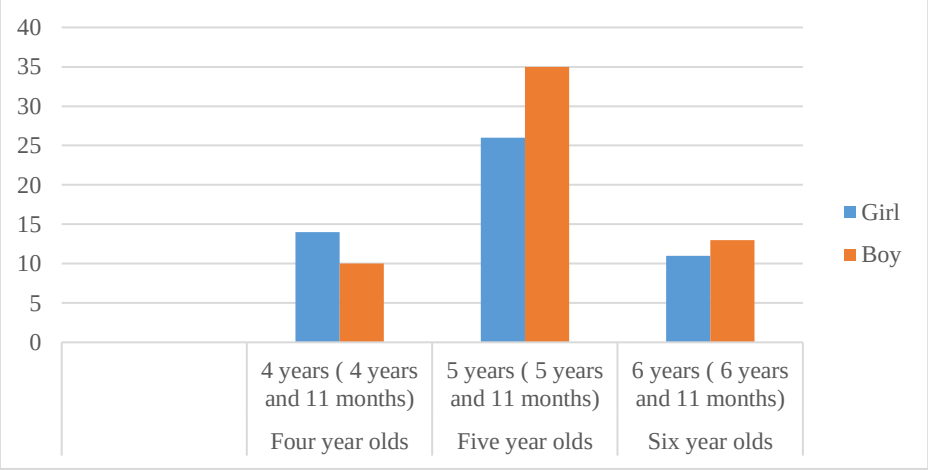
IBM SPSS Statistics version 21 (IBM Corp., Armonk, NY, USA) was used to analyze the results, which were considered significant if $p < 0.05$ and with a confidence interval of 95%. The mean and standard deviation of age, gender, and BMI were calculated.

The Kolmogorov-Smirnov test was used to determine a normal distribution, which suggested that the distribution of the data results was not normal. So, Spearman's correlation coefficient was used to determine the relationship between quantitative variables, which was a nonparametric test. (The p-value is <0.05)

Results

One hundred seven preschool children, 58 boys, and 51 girls, participated in the study. The average age of the boys and girls was five years old.

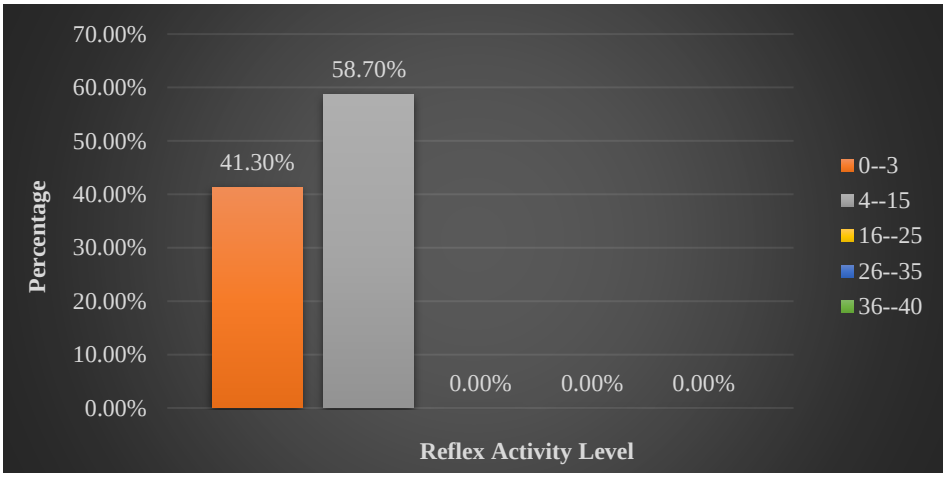
Graph 4.2.1: **Characteristics of the participants.**



Test of reflex activity level

The results of the score obtained during the evaluation of all reflexes (up to 40 scores) were converted to the level of reflex activity. The results showed that 41.30 % of the children tested integrated their reflexes, and 58.70% had a low reflex activity level. Moderate or high levels of reflex activity were not observed in any of the children, and no child showed the highest level of reflex activity. The results for the reflex activity levels are shown in Graph 4.2.2.

Graph 4.2.2: **The results for the level of reflex activity.**



Results of the APR Examination

The most common reflexes of preschooler children were GALANT L (53.2 %), GALANT R (44.90%), and TLR E (59.7%). Slightly fewer children showed a TLR F (40.3%) and ATNR L (41.30%) reflex. Palmar grasp was not frequent. The most expressed reflexes at maximum intensity were the TLR E reflex (18.30%) and the TLR F reflex (01.80%).

TLR E (1%) expressed high activity. The maximum degree for all reflexes was absent. The results expressed as a percentage are shown in Table 4.2.1.

Table 4.2.1: **The results of the examination of reflexes.**

Scale	ATNR R	ATNR L	GALANT R	GALANT L	PALMER R	PALMER L
0	74.30%	58.70%	55.00%	46.80%	100%	100%
1	25.70%	41.30%	43.10%	51.40%	0.00%	0.00%
2	0.00%	0.00%	1.80%	1.80%	0.00%	0.00%
3	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%

ATNR R/L—asymmetrical tonic neck reflex (right/left); STNR F/E—asymmetrical tonic neck reflex (flexion/extension); TLR F/E—tonic labyrinthine reflex (flexion/extension).

Scale	STNR F	STNR E	TLR F	TLR E	MORO
0	66.10%	79.80%	59.60%	41.30%	98.20%
1	33.00%	19.30%	38.50%	40.40%	1.80%
2	0.90%	0.90%	1.80%	18.30%	0.00%
3	0%	0%	0%	1%	0%
4	0%	0%	0%	0%	0%

MOT 4–6 Results

The final scores of preschool children in MOT 4-6 are shown in Graph 4.2.3.

The most difficult tasks for the child were grasping tissue with toes (No. 3), catching a stick (No. 5), and reverse balance (No. 7); about 80% of children did not complete these tasks. The simplest tasks are to place dots on the sheet (No. 2), passing through a hoop (No. 10), and rolling around the long axis of the body (No. 15). 96.33% of children completed Task 2, nearly 92.66% completed Task 10, and nearly 96% completed Task 15. Tables 4.2.2 and 4.2.3 show the percentage results for children with the maximum and minimum scores achieved by children in MOT 4–6

Graph 4.2.3: The MOT 4–6 final results.

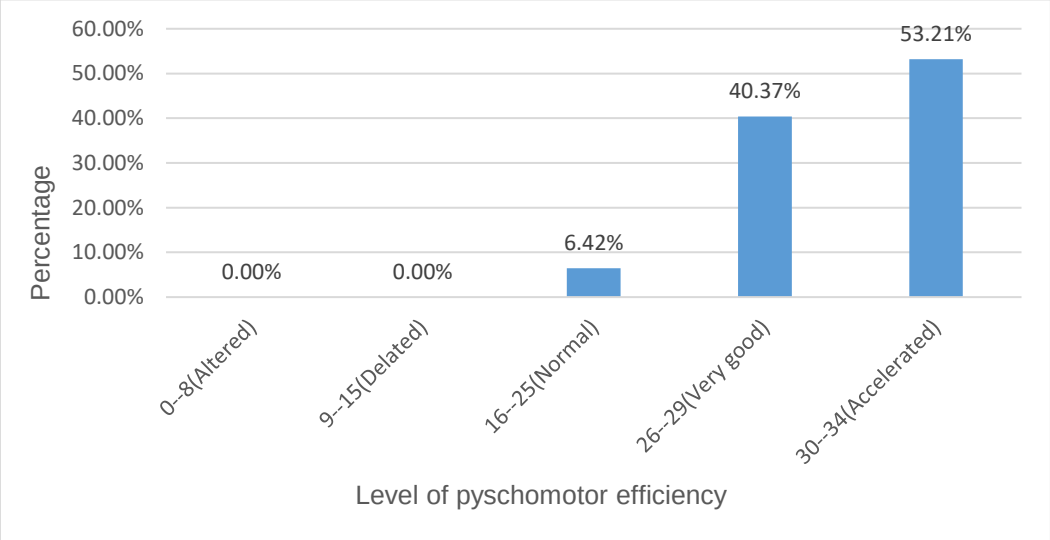


Table 4.2.2: The results of MOT 4–6 for tasks 1–8.

Scale	1	2	3	4	5	6	7	8
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	24.77%	3.67%	36.70%	30.28%	42.20%	1.83%	78.90%	19.27%
2	75.23%	96.33%	63.30%	69.72%	57.80%	98.17%	21.10%	80.73%

Table 4.2.3: The results of MOT 4–6 for tasks 9–17.

Scale	9	10	11	12	13	14	15	16	17
0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
1	17.43%	7.34%	34.86%	35.78%	14.68%	8.26%	2.75%	10.09%	30.28%
2	82.57%	92.66%	64.22%	64.22%	85.32%	91.74%	97.25%	89.91%	69.72%

The Results of the Motor Proficiency Test and Active Primitive reflex Activity

Statistical analysis showed that reflex activity was inversely correlated with motor proficiency (MOT 4-6), $p < 0.05$. Consequently, children with strong activity of reflex lead to low motor proficiency. There is also a positive relationship between MOT level and individual reflex activity.

The strongest statistically significant correlations were for ATNR_L and GALANT_R, TLR_F, and TLR_E (-0.246, -0.240, -0.259, -0.239). The correlation coefficient analysis between MOT 4-6 and reflex activity is shown in Table 4.2.4.

Table 4.2.4: The correlation coefficient between active primitive reflex and MOT levels.

Reflex	Correlation Coefficient	P –Value
ATNR_R	-0.067	0.522
ATNR_L	-0.246*	0.017
GALANT_R	-0.240*	0.020
GALANT_L	-0.139	0.183
PALMER_R	-	-
PALMER_L	-	-
STNR_F	-0.140	0.178
STNR_E	-0.136	0.192
TLR_F	-0.259*	0.012
TLR_E	-0.239*	0.020
MORO	0.007	0.948

*Correlation is significant at $p < 0.05$ level

- No reflex activity

The correlations between individual MOT 4–6 tasks and APR levels were found. Grasping a tissue with toes (No. 3), sideward jump (No. 4), reverse balance (No. 7), Catching a tennis ring (No. 12), jumping jacks (No. 13), and Jumping and turning in a hoop (No. 17) had the strongest correlations with total tonic reflex scores. The relationships between each Task of MOT 4-6 with the levels of reflex activity were presented in Table 4.2.5.

Table 4.2.5: The correlation coefficient of active primitive reflex levels with individual tasks from the MOT test.

MOT 4 – 6 task	Coefficient Correlation	P –Value
01. Forward balance	-0.023	0.824
02. Placing dots on a sheet	0.013	0.902
03. Grasping a tissue with toes	-0.412**	0.000
04. Sideward jump	-0.326**	0.001
05. Catching a stick	-0.148	0.155
06. Carrying balls from one box to another	-0.147	0.158
07. Reverse balance	-0.433**	0.000
08. Throwing at a target disk	-0.167	0.107
09. Collecting matches	-0.110	0.293
10. Passing through a hoop	-0.083	0.426
11. Jumping in a hoop on 1 foot, standing on 1 leg	-0.155	0.136
12. Catching a tennis ring	-0.221**	0.033

13. Jumping jacks	-0.243**	0.018
14. Jumping over a cord	-0.126	0.228
15. Rolling around the long axis of the body	-0.113	0.280
16. Standing up while holding a ball on the head	0.013	0.901
17. Jumping and turning in a hoop	-0.312**	0.002

*Correlation is significant at $p < 0.05$ level

**Correlation is significant at $p < 0.01$ level

The Level of active primitive Reflex and Sensory profile

Spearman's correction applied showed that the APR level was positively correlated with the individual via the sensory profile. The correlation coefficient analysis between SP-2 and reflex activity is shown in Table 4.2.6.

Table 4.2.6: Coefficient of determination of sensory profile with the corresponding active primitive reflexes.

Sensory Profile	Level of Reflex Activity (CC)	P -Value
Seeking	-0.064	0.543
Avoiding	-0.096	0.359
Sensitivity	0.023	0.825
Registration	-0.095	0.365
Auditory	-0.159	0.133
Visual	-0.133	0.200
Touch	0.098	0.348
Movement	-0.146	0.160
Body position	-0.032	0.758
Oral	0.181	0.080
Conduct	-0.158	0.129
Social-Emotional	0.038	0.716
Attentional	-0.174	0.093

The correlations were also found in individual APR and sensory profiles. Correlations were strongest for GALANT_R with registration, STNR_E with registration, auditory and movement, TLR_F with auditory, and TLR_E with oral and conduct, and sensory profiles scores. The correlations between individual tasks and sensory Profiles for individual active primitive reflexes are shown in Table 4.2.7.

Table 4.2.7: Coefficient of determination of sensory profile with the specific active primitive reflexes.

	Seeking	Avoiding	Sensitivity	Registration	Auditory	Visual	Touch
ATNR_R	.165	.103	-.075	-.076	-.015	.020	.095
p – Value	.112	.322	.471	.469	.885	.846	.363
ATNR_L	-.054	-0.46	.051	-.045	-.054	-.053	.067
p – Value	.606	.657	.624	.668	.607	.612	.523
GALANT_R	-.094	-.019	.135	.216*	-.021	.139	.044

p – Value	.366	.366	.196	.036	.841	.182	.671
GALANT_L	-.151	-.068	-.036	-.024	-.078	-.017	-.055
p – Value	.147	.516	.734	.817	.817	.454	.597
PALMER_R - L	-	-	-	-	-	-	-
STNR_F	.199	.167	.197	-.013	.176	-.007	.100
p – Value	.055	.108	.057	.901	.090	.950	.340
STNR_E	-.039	-.114	-.149	-.257*	.027*	-.032	-.029
p – Value	.709	.272	.151	.012	.799	.757	.781
TLR_F	-.020	-.097	.048	-.091	-.203*	-.173	.121
p - Value	.850	.353	.644	.381	.050	.096	.244
TLR_E	.073	-.114	-.034	.085	-.155	-.150	.049
p - Value	.485	.273	.745	.417	.136	.150	.642
MORO	-.107	-.093	-.019	-.142	-.118	.023	-.036
p - Value	.303	.375	.855	.173	.256	.824	.734

	Movement	**Body Position**	**Oral**	**Conduct**	**Social-Emotional**	**Attentional**
ATNR_R	.037	-.169	-.056	.093	.085	.120
p - Value	.722	.104	.594	.372	.416	.250
ATNR_L	-.080	.106	-.012	-.162	.059	-.058
p - Value	.446	.307	.907	.120	.571	.582
GALANT_R	.031	.066	.190	-.019	-.004	-.099
p - Value	.766	.525	.066	.856	.973	.342
GALANT_L	.-.108	-.199	.049	-.113	-.043	-.130
p - Value	.301	.055	.642	.278	.683	.213
PALMER_R - L	-	-	-	-	-	-
STNR_F	.090	.147	.108	.195	.082	.128
p - Value	.387	.158	.300	.059	.430	.220
STNR_E	-.254*	-.181	-.163	.090	.088	-.158
p - Value	.014	.081	.117	.390	.398	.128
TLR_F	-.045	.070	.136	-.201	-.030	-.108
p - Value	.668	.506	.190	.052	.773	.299
TLR_E	-.071	.061	.229*	-.204*	-.069	-.130
p - Value	.497	.560	.026	.049	.509	.213
MORO	-.178	-.010	-.096	-.093	-.001	-.022
p - Value	.086	.927	.359	.374	.990	.835

*Correlation is significant at $p < 0.05$ level

- No reflex activity

Discussion

Our study aimed to verify whether the level of APR is associated with motor performance and sensory skills. The study of APR with motor and sensory skills is an important aspect of the development screening, which is untouched. We hypothesized that the increased primary reflexes were linked to decreased motor and sensory performance.

The literature on primary reflexes in people with neurological impairments, such as cerebral palsy, post-stroke [2], learning disabilities, and attention disorders [17], [18], is extensive. However, research on the consequences of APRs and the importance of motor and sensory skills in preschool children's development remains limited. Therefore we have started to export them. The examined children in this study differ from those in the existing literature. Goddard-Blythe et al. [19] pointed out that weak and little expressed reflexes can be integrated spontaneously with age. However, multiple well-expressed reflexes lead to neurodevelopmental delays [20].

- **APRs in Preschool Children Concerning Age**

In our study**,** APRs were found in 86% of the children examined. In our study, no child showed the highest level of reflex activity. Hickey and Feld hacker et al. [8] showed that 100% of children aged 4 to 6 old had at least one retained reflex. Goddard studied children aged 4 to 5 years and reported similar results [21]. Pecuch et al. [22] studied 6 APRs (ATNR, STNR, TLR, Moro, Palmar, and Galant reflex) in children aged 4 to 6 years and found that one of these reflexes was present in 98% of preschool children.

In our study, the results of the Spearman correlation suggest that older children have the potential to achieve better motor performance with a simultaneous decrease in reflex activity levels. Studies comparing preschool and school-aged children have shown that the levels of reflex activity decrease with age [6].

However, if the process of spontaneous integration of reflexes does not run correctly, it can affect the child's functioning in terms of acquiring motor and sensory skills related to balance, coordination, education, and social life.

- **The APRs related to motor skills**

The correlation between tonic activity and the final score of the MOT 4–6 suggests an inverse relationship between the degree of non-integration of reflexes and motor proficiency of preschool children. The same was shown in research by Gieysztor [23], who also examined preschool children for the presence of tonic reflexes and motor performance in preschool children using the MOT 4–6. Our new study was conducted on a larger group of children (107 study participants) than most of the current reflex studies. We also extended the analysis of the results to establish correlations of the six reflexes with the levels of MOT and the individual motor tests with the levels of active reflexes. Most reflexes were significantly correlated with children's motor performance level.

- **Motor skills of preschool children**

Our research showed that the most difficult test to perform from the MOT 4–6 set of tasks was grasping tissue with toes (No. 3), catching stick (No. 5), and reverse balance (No. 7), with 80% of children having difficultly during tasks. The easiest task of placing dots on a sheet (No. 2) and passing through a hoop (No. 10). Gieysztor study [44] confirms that these two tests were the most difficult to perform for preschool children, and task No. 2 was the easiest.

The majority of children were in the "normal development" range (75% in Cools et al., 59% in Gieysztor, 6.42% in our study). In our study, 0 % of children were classified as having "altered

development" (4% in Cools et al., 9% in Gieysztor). In our research, 40.37% of children were in "very good development." A similar result was found by Cools et al.—1%; and Gieysztor—3%. As in Cools et al. and Gieysztor's study, no child achieved "accelerated development" results. This result occurred in 53.21% of cases in our study, which is the highest percentage from all-over results. No child was classified as altered development.

In recent years, additional physical activities have become increasingly available, in which allowing even very young infants can considerably develop their motor skills.

- **The APRs related to sensory skills**

In our study, the sensory profile was also determined by the parents -average scores for a sensory profile strongly correlated with the attentional and movement deficit. Our research shows that a group of preschoolers whose parents perceived more sensory impairments is associated with outcomes related to correlations of sensory traits. This was help to determine the percentage of the population with mild to moderate loss of reflexes and whether their presence will cause serious development issues in the future. Gieysztor also made the same conclusion in his research [6].

Some studies have confirmed the relations among sensory impairment and primary reflex activity. Our results show that individual reflexes do not generally appear to be associated with individual sensory impairments.

The Spearman correlation coefficient of indicated that attentional and oral were strongly related to reflex activity levels. These results indicate that children with coordination and movement issues had more and greater APRs than children who did not have the above difficulties.

The immediate reason for this is that the meaning of children in our study is related to the functioning of the structures responsible for balance, proprioception, and touch, perhaps because of less exposure to the environment.

Conclusion

This study concluded that 86% of preschoolers had retained primitive reflexes of measurable reflexes.

The relationship between APR and motor skills suggests that the presence of APR affects the motor skills of preschool children. But in normal preschool children, the presence of APR is mild to moderate and does not significantly affect their motor performance.
The correlation between APR and sensory processing observed by parents suggests that examination of the child's primary reflexes could be a good screening tool to determine the growth of the child that is related to sensory affection in movement, oral and auditory that has APR present.

LIMITATIONS OF THE STUDY

- Individual fine motor skills were not tested in the current study.
- For sensory skills, we only use sensory profile 2, which is completed by parents, not through sensory tools.

FUTURE RECOMMENDATIONS

- Screen and evaluate a child who was born prematurely and its relationship to the child's APR and sensory development.
- Can perform a longitudinal study from 12 months of age by examining APR, motor development, and sensory development and reexamined after a year.
- Make a plan for well-chosen therapy to treat the children and identify problems in a way that will significantly improve the effectiveness of other therapeutic activities.
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- **Informed Consent Statement:** All subjects who took part in the study provided informed consent.
- **Data Availability Statement**: The data that support the presented result can be received directly from the correspondent author who is in charge of deals with data storage.

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