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The Relationship Between Retained Primitive Reflex Activity and Motor Skills in Preschool-Aged Children: A Systematic Review

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Abstract

Aims: This systematic review synthesizes the available evidence on the association between retained primitive reflex activity and gross and fine motor performance in preschool-aged children and examines what conclusions can be drawn regarding motor development and school readiness.

Methods: This review was conducted and reported in accordance with the PRISMA 2020 statement. This review was not prospectively registered. PubMed, Scopus, EBSCOhost, ProQuest, SpringerLink, Taylor & Francis, SAGE, and ClinicalKey were searched on 1 January 2025, with results limited to records published between 1 January 2015 and 1 January 2025; Google Scholar was used as a supplementary source for citation chasing. Eligibility followed a PICOS framework: preschool-aged children; exposure defined as retained primitive reflex activity graded with a standardized scale; outcomes defined as gross or fine motor performance measured with a standardized instrument; observational and quasi-experimental designs; published in English or Indonesian. Records were deduplicated and screened independently by two reviewers. Methodological quality was appraised using the Joanna Briggs Institute (JBI) critical appraisal checklists. Findings were synthesized narratively; meta-analysis was not undertaken because of heterogeneity in populations, instruments, and reported effect measures.

Results: Ten studies involving 635 children met the eligibility criteria. Across the included studies, higher levels of retained primitive reflex activity were most consistently associated with asymmetrical tonic neck reflex (ATNR), followed by symmetrical tonic neck reflex (STNR), tonic labyrinthine reflex (TLR), and Moro reflex, and poorer performance on standardized motor assessments, particularly in balance, coordination, postural control, and bilateral integration. 9 of 10 studies reported statistically significant associations. Associations with sensory processing were reported in one study and with school readiness or academic performance in two studies. All included studies used observational designs, and no pooled effect estimate could be derived.

Conclusion: Retained primitive reflexes are consistently associated with poorer motor performance in preschool-aged children and may have implications for their school readiness. However, as the available evidence is observational, causality cannot be inferred. Structured reflex assessment within developmental screening may support earlier identification and referral; however, prospective longitudinal and interventional studies using standardized instruments are required before firm clinical recommendations can be made.

Keywords: Abnormal reflex; Child development; Motor skills; Psychomotor performance; Sensorimotor development

Introduction

The preschool years are a crucial period in determining a child's readiness for formal education [1-5]. During this phase, children are expected to achieve readiness in physical, emotional, and cognitive domains to participate successfully in primary school learning [2,6]. However, many children are not fully prepared for this transition. Approximately 15–25% of preschool-aged children experience developmental difficulties affecting motor and cognitive skills, with potential consequences for academic performance [7]. One factor associated with this pattern is incomplete integration of primitive reflexes [2,5,8,9].

Primitive reflexes are automatic movement responses present in infancy that support early interaction with the environment and survival [2,5,8,10]. Throughout this review, the term retained primitive reflexes is used to denote the persistence of measurable primitive reflex activity beyond the age at which integration is normally complete. Related terms appearing in the primary literature, unintegrated, persistent, or residual primitive reflexes, are treated as equivalent, and the term primitive reflex activity level is used only when referring to the graded score generated by a standardized assessment scale. Reflexes commonly reported as remaining active include the asymmetrical tonic neck reflex (ATNR), symmetrical tonic neck reflex (STNR), tonic labyrinthine reflex (TLR), and Moro reflex [9,11-13]. In one preschool sample, approximately 11% of children showed fully integrated primitive reflexes, while 89% exhibited at least one retained reflex, of which 65% represented residual-level activity only [14]. Retention of these reflexes in preschool-aged children has been associated with a range of developmental difficulties, particularly in motor skill development [1,12,14,15].

The development of gross and fine motor skills is a central aspect of early childhood development [3,15]. The integration of primitive reflexes has been described as a foundation for motor and cognitive control [3,5]. Retained ATNR has been associated with reduced coordination between the upper and lower limbs, whereas retained STNR has been associated with difficulty in fundamental patterns such as crawling and climbing [12,16-19]. Retained TLR has been associated with difficulties in postural control, balance, and fine motor performance [9,20]. A retained Moro reflex has been associated with heightened startle responsiveness, difficulty maintaining stillness, and difficulty with precise fine motor tasks [14,17,21,22].

Although the association between retained primitive reflexes and developmental outcomes has attracted increasing attention, the evidence base remains fragmented. A previous systematic review examined the relationship between learning disorders, motor function, and primitive reflexes in preschool children [22]; however, its primary focus was learning disorders rather than motor performance as an outcome in its own right, and it did not organize findings by individual reflex or by motor outcome domain. Beyond that review, the available primary studies differ substantially in participant age ranges, health status, the instruments used to grade reflex activity, and the motor outcome measures applied, which has produced inconsistent and difficult-to-compare findings. To date, no synthesis has specifically examined which retained reflexes are associated with which motor outcome domains among preschool-aged children, nor has it assessed the consistency of these associations in relation to the methodological quality of the underlying studies.

This systematic review was undertaken to synthesize and critically appraise the current evidence on the association between retained primitive reflex activity and gross and fine motor performance in preschool-aged children, and to identify where the evidence is consistent, where it diverges, and what methodological limitations constrain its interpretation.

Methods

2.1 Design and reporting

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. The completed PRISMA 2020 checklist is provided as Supplementary File S1.

2.2 Search strategy

A three-block search strategy was developed, combining terms for exposure (primitive reflexes), population (preschool children), and outcome (motor skills). Controlled vocabulary was used where available and combined with free-text terms. The strategy was developed in PubMed and adapted for each subsequent database. Searches were executed on 1 January 2025 and limited to records published between 1 January 2015 and 1 January 2025 and in English or Indonesian. The PubMed strategy was as follows:

> *("primitive reflex*"[tiab] OR "retained primitive reflex*"[tiab] OR "primitive motor reflex*"[tiab] OR "Reflex, Abnormal"[Mesh]) AND ("preschool child*"[tiab] OR "pre-school child*"[tiab] OR "young child*"[tiab] OR "early childhood"[tiab] OR "Child, Preschool"[Mesh]) AND ("motor skill*"[tiab] OR "motor development"[tiab] OR "gross motor"[tiab] OR "fine motor"[tiab] OR "Motor Skills"[Mesh] OR "Psychomotor Performance"[Mesh])*

Google Scholar was used as a supplementary source and for citation chasing rather than as a primary database; its yield is reported separately in the study selection flow. The reference lists of all included studies and the previous review by McWhirter et al. (2024) were hand-searched. The full search strategies, execution dates, and record counts for every database are reported in Supplementary Table S1.

2.3 Eligibility criteria

Eligibility was defined a priori using the PICOS framework (Table 1). Both observational and quasi-experimental designs were included because the exposure of interest was not amenable to randomization, and the observational literature constitutes the majority of the available evidence. Studies of clinical populations were eligible but were analyzed and reported separately from studies of typically developing children.

Table 1. Eligibility criteria (PICOS framework)

Domain	Inclusion criteria	Exclusion criteria
Population (P)	Children of preschool age (3–6 years). Studies including children outside this range were eligible only if data for preschool-aged participants were reported separately. Typically developing children and defined clinical populations (e.g. ADHD) were both eligible and were analyzed separately.	Studies in which preschool-aged data could not be separated; exclusively infant, school-age, or adult samples.
Exposure (E)	Retained primitive reflex activity was assessed using a standardized, graded assessment scale.	Reflex status was reported only as present/absent without grading or assessed using an undescribed method.
Comparator (C)	Children with integrated reflexes or with lower-graded levels of reflex activity (within-sample comparison acceptable).	No comparison of reflex activity levels was made.
Outcomes (O)	Primary: gross or fine motor performance measured using a standardized motor assessment instrument. Secondary: sensory processing, school readiness, and academic performance.	Studies reporting reflex status only, with no motor outcomes measured.
Study design (S)	Cross-sectional, correlational, comparative observational, cohort, and quasi-experimental studies	Case reports, case series, narrative and systematic reviews, editorials, theses, and conference proceedings.
Publication	Peer-reviewed journal articles, full text available, published between January 1, 2015, and January 1, 2025, in English or Indonesian.	Non-peer-reviewed sources, books, abstracts only, records outside the publication window, or language range.

2.4 Study selection

Records retrieved from all sources were imported into a reference manager, deduplicated automatically, and verified manually. Titles and abstracts were screened independently by two reviewers against the eligibility criteria. The full texts of all potentially eligible records were then assessed independently by the same two reviewers. Disagreements at either stage were resolved by discussion, with a third reviewer available for adjudication. [Report inter-rater agreement here if calculated.] The selection process is presented in Figure 1 as a PRISMA 2020 flow diagram, including the number of duplicates removed and the reasons and counts for exclusion at the full-text stage.

2.5 Critical appraisal

Methodological quality was appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies for observational studies and the JBI Checklist for Quasi-Experimental Studies for interventional studies. Two reviewers appraised each study independently, and disagreements were resolved through discussion with a third reviewer. Studies were not excluded on the basis of the appraisal score. Instead, the appraisal results were used to weight the interpretation during synthesis, and findings drawn from studies with substantial methodological concerns were identified as such in the Results. JBI critical appraisal was not conducted; therefore, item-level methodological quality assessment results are not available.

2.6 Data extraction and synthesis

Data were extracted independently by two reviewers using a form piloted in two studies. The form captured the author, year, country, study design, sample size, age range, health status, reflexes assessed, reflex assessment instrument, motor outcome instrument, reported statistical results including effect estimates and p-values, and key findings. Discrepancies were resolved through consensus.

Because of heterogeneity in participant characteristics, assessment instruments, and reported effect measures, a meta-analysis was not appropriate. A narrative synthesis was conducted in line with the Synthesis Without Meta-analysis (SWiM) reporting guidance. Findings were grouped first by motor outcome domain and then by individual reflex, and the direction and statistical significance of each reported association were tabulated to permit assessment of consistency across studies

Results

3.1 Study selection

The search retrieved 2,578 records across the six databases: Google Scholar (n = 1,230), PubMed (n = 920), Scopus (n = 71), Taylor & Francis (n = 214), SAGE (n = 11), and ClinicalKey (n = 132). After screening based on titles and abstracts, 52 records were reviewed, while 2,526 records were excluded because they were not related to primitive reflexes and motor skills in preschool-aged children, were not written in English or Indonesian, or were unavailable in full text. Subsequently, 15 full-text articles were considered relevant to the research topic and assessed for eligibility criteria. After assessing the inclusion and exclusion criteria, 10 studies were included in the narrative synthesis. The selection process is illustrated in Figure 1.

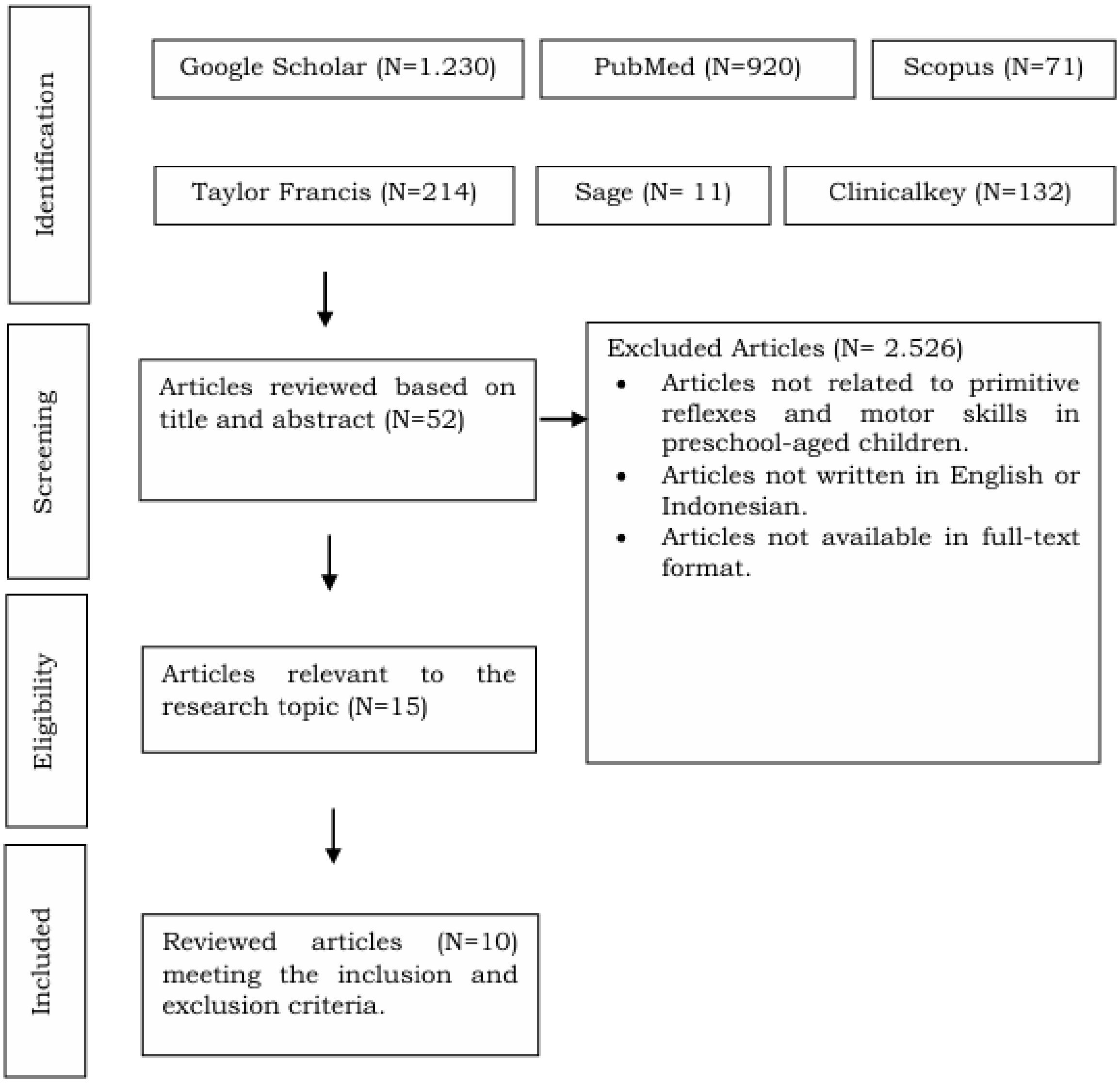

Figure 1. PRISMA 2020 flow diagram of study selection

3.2 Characteristics of included studies

The included studies were published between 2015 and 2025 and were conducted in six different countries. Seven studies used cross-sectional or comparative observational designs, and one used a quasi-experimental design. Sample sizes ranged from 2 to 233 participants (total 771), with mean ages between 4.5 and 7.6 years. Nine studies recruited typically developing children, and one recruited defined clinical populations. Primitive reflex activity was graded using the Sally Goddard rating scale in all 10 studies; motor performance was most frequently assessed using the Motor Proficiency Test for children aged 4–6 years (MOT 4–6) and the Movement Assessment Battery for Children (MABC / MABC-2). This concentration of instruments facilitates comparison across studies; however, any limitation of those instruments propagates across the evidence base rather than averaging out. The characteristics of the individual studies are presented in Table 2.

Table 2. Characteristics and findings of the included studies

Author (year)	Country	Design	Participants	Reflexes assessed	Instruments	Reported statistical result	Key finding
Pecuch A et al. (2021)	Poland	Cross-sectional observational	112 children aged 4–6 y (63 girls, 49 boys), 3 kindergartens, Lower Silesia; typically developing	Tonic reflexes (ATNR, STNR, TLR)	Sally Goddard rating scale; MOT 4–6	High primitive reflex activity was significantly associated with lower gross motor proficiency; total reflex score vs. MOT 4–6 ($r=-0.327$, $p<0.05$), APR vs. MOT 4–6 ($\beta=-0.17$, $p=0.023$).	Higher tonic reflex activity was associated with lower motor efficiency.
Hernandez A et al. (2023)	Spain	Comparative cross-sectional	233 children, mean age 5.3 y, 8 kindergartens; typically developing	Multiple primitive reflexes	Sally Goddard rating scale; MABC	Skipping the crawling stage is strongly associated with reflex retention and lower motor competence; spinal galant ($U=720.0$, $p<0.001$} and Mabc-2 Total vs. crawling pattern ($U=227.0$, $p<0.001$}.	Lower reflex integration was associated with poorer motor competence and crawling difficulty; the pattern was more marked in boys.
Rathod DHP et al. (2024a)	India	Cross-sectional observational	107 kindergarten children aged 4–6 y, Bardoli, Gujarat; typically developing	Multiple primitive reflexes	Sally Goddard rating scale; MOT 4–6; Sensory Profile 2	Active primitive reflexes are highly prevalent in healthy preschoolers and negatively impact physical coordination: TLR F vs. MOT 4–6 ($r=-0.259$, $p=0.012$} and	An inverse association between reflex activity level and motor skills has also been reported with sensory processing.

Author (year)	Country	Design	Participants	Reflexes assessed	Instruments	Reported statistical result	Key finding
						ATNR L vs. MOT 4–6 (r=-0.246, p=0.017}.	
Gieysztor E et al. (2022)	Poland	Cross-sectional observational	Preschool children, mean age 5.5 y; typically developing	ATNR, STNR	Sally Goddard rating scale; Schilder test; Romberg test	Primitive reflex persistence significantly alters children's normal walking gait parameters; it influences left step length (p=0.0002} and gait cycle duration (p=0.0099}.	ATNR and STNR activity was associated with gait pattern variation, which was interpreted as reduced neuromotor maturity.
Feldhacker DR et al. (2022)	USA	Quantitative correlational	53 children aged 5–7 y (24 kindergarten, 29 first grade; 31 boys, 22 girls)	ATNR and others	Sally Goddard rating scale; Woodcock-Johnson Test of Cognitive Abilities	Reflex retention (specifically ATNR R) significantly correlates with lower academic performance in boys; ATNR R vs. spelling (r=-0.530, p=0.003} and math (r=-0.431, p=0.020).	Retained ATNR was associated with lower scholastic performance, particularly among boys. Age range extends beyond preschool.
Goddard Blythe S et al. (2022)	United Kingdom	Quasi-experimental, pretest–posttest with control group	Children aged 4–5 y from 4 schools, first year at school	ATNR and others (neuromotor immaturity)	INPP Developmental Screening Test and School Intervention Programme; MABC-2	A daily developmental movement program is highly effective in integrating primitive reflexes; reduction of combined reflex scores in the	Neuromotor immaturity was prevalent; retained ATNR was associated with lower attainment and hand–eye coordination and

Author (year)	Country	Design	Participants	Reflexes assessed	Instruments	Reported statistical result	Key finding
						intervention group vs. control (U=2090.5, p<0.001).	oculomotor difficulties.
Gieysztor EZ et al. (2018)	Poland	Cross-sectional	35 children aged 4–6 y; typically developing	ATNR, STNR and others	Sally Goddard rating scale; MOT 4–6	Left ATNR was retained in 66% of the preschoolers, while STNR flexion was retained in 34%. Greater severity of persistent primitive reflexes was significantly associated with lower psychomotor efficiency (total reflex score vs. MOT 4–6: r=−0.34, p<0.05).	Greater reflex retention was associated with lower motor scores, most markedly on complex coordination tasks; premature birth was associated with greater retention.
Gieysztor E et al. (2019)	Poland	Cross-sectional	45 children aged 6–7 y, Wroclaw	Overall reflex integration level	Sally Goddard rating scale; musical training exposure (piano, guitar, violin)	Children undergoing musical instrument training demonstrated significantly higher neuromotor maturity and better reflex integration than non-trained children (p<0.03), with 8% of non-trained children classified at reflex integration level 3, compared with none of the	Musical training exposure was associated with lower reflex retention. Outcome is reflex integration, not motor skill; age above preschool range.

Author (year)	Country	Design	Participants	Reflexes assessed	Instruments	Reported statistical result	Key finding
						trained children.	
Bogdanoviča I & Lāriņš V (2020)	Latvia	Case study (2 participants)	Two girls aged 7 y	ATNR, STNR, TLR	Sally Goddard rating scale; swimming skill assessment (Oh et al., 2011)	Severe reflex retention acts as a significant barrier to swimming skill acquisition; Case 1 (8% severity, 77% swimming mastery) vs. Case 2 (25% severity, 33% swimming mastery) (no formal p-value due to N=2 case study design).	More retained reflexes accompanied lower swimming skill. Conference proceedings, case design, and age above the preschool range.
Rathod DHP et al. (2024b)	India	Cross-sectional	14 children aged 4–6 y with ADHD, paediatric clinic, Surat	Right ATNR, Moro, STNR extension, right Spinal Galant	Sally Goddard rating scale; MOT 4–6; parent questionnaire	Among children with ADHD, the right ATNR was present in 42.9%, followed by Moro (35.7%), STNR extension (28.6%), and right Galant (21.4%). Active primitive reflexes were significantly associated with poorer motor coordination (STNR F vs. MOT 4–6: $r=-0.804$, $p=0.001$; TLR F vs. MOT 4–6: $r=-0.758$, $p=0.002$).	Higher reflex activity was accompanied by greater difficulty in balance, coordination, and fine and gross motor control. Clinical population.

3.3 Methodological quality of included studies

JBI critical appraisal was not conducted; therefore, item-level methodological quality assessment results were not available, and no appraisal results were used to weight the interpretation during synthesis or to exclude studies.

3.4 Synthesis of findings

3.4.1 Level and prevalence of retained primitive reflexes

Retained primitive reflex activity was common across all samples of preschool-aged children. The reported prevalence ranged from 86% of children showing at least one retained reflex in an Indian kindergarten sample [15] to a majority of children in a smaller Polish sample, in which the left ATNR was the most frequently retained reflex (66%) and STNR flexion was the least frequent (34%) [14]. Studies reporting graded activity levels generally found that most retention was at the residual or mild levels rather than at the highest grades. Direct comparison of prevalence estimates is limited by differences in sample size, setting, and cut-off points applied to the grading scale.

3.4.2 Association with gross motor outcomes

Gross motor performance was the most frequently reported outcome domain. Across studies using MOT 4–6 and MABC/MABC-2, higher levels of retained reflex activity were accompanied by lower scores in balance, coordination, and postural control [12,14,15,17]. This association was most pronounced on tasks requiring complex or bilateral coordination rather than simple locomotor items [14]. Gait characteristics were examined in one study, in which ATNR and STNR activity accompanied variations in walking patterns, interpreted by the authors as an index of reduced neuromotor maturity [18]. The direction of association was consistent across all studies reporting gross motor outcomes; however, the magnitude of association could not be summarized because the effect estimates were reported inconsistently.

3.4.3 Association with fine motor outcomes

Fine motor outcomes were reported less frequently and with greater variation in operationalization, ranging from manual dexterity subtests to hand–eye coordination and graphomotor tasks. Retained reflex activity accompanied poorer performance on precision and manual dexterity items [15,17], and retained ATNR in particular accompanied difficulty with hand–eye coordination and oculomotor control among children in their first year of school [19]. Because fine motor performance was assessed using different instruments and subtests across studies, consistency in this domain is weaker than that for gross motor outcomes.

3.4.4 Reflex-specific patterns

The ATNR was the most frequently examined reflex and showed the most consistent association with motor outcomes, including bilateral coordination, gait symmetry, hand–eye coordination, and graphomotor tasks [14,15,17-19,23,24]. The STNR has been examined in fewer studies and has been reported in relation to crawling, sitting posture, and transitional movement patterns [18,19]. TLR has been reported principally in relation to postural control and balance, but has been assessed in the smallest number of studies, and the evidence for it is correspondingly weaker [8,9]. The Moro reflex and the Spinal Galant reflex were reported almost exclusively within a clinical sample of children with ADHD, and findings for these reflexes should not be generalized to typically developing populations [25].

Table 4. Reflexes assessed × motor outcome domain × direction of association, by study

Study / Journal	ATNR (Asymmetrical)	STNR (Symmetrical)	TLR (Labyrinthine)	Moro Reflex	Spinal Galant
Anna Pecuch (2021)	↓ (B, C, P)*	↓ (C, P)*	↓ (B, C)*	—	—
Dr. Heena (2024)	↓ (B, C, FM)*	↓ (B, C, P)**	↓ (B, C, P)**	ns	ns
Andrea (2023)	↓ (B, C)*	↓ (FM)*	↓ (B, C)**	—	↓ (FM, C)**
Dr. Heena (2024)	↓ (B, C)*	ns	↓ (B, C)*	ns	↓ (B, C)*
Ewa G. (2022)	↓ (P, C)*	↓ (P, C)*	↓ (P)*	↓ (P, C)*	↓ (P)*
Diana (2022)	↓ (FM, C)**	ns	↓ (FM, C)*	↓ (C)**	↓ (C)*
Sally Goddard B (2021)	↓ (B, C, P)**	↓ (B, C, P)**	↓ (B, C, P)**	—	—
Ewa Z. Gieysztor (2018)	↓ (B, C)*	↓ (B, C)*	↓ (B, C)*	—	—
Ewa G. (2019)	↓ (B, C, P)*	↓ (B, C, P)*	↓ (B, C, P)*	—	—
Irina (2020)	↓ (C) [Qual]	↓ (C, P) [Qual]	↓ (B) [Qual]	—	—

Legend:
↓: Statistically significant negative association (higher reflex retention correlates with poorer performance or impairment in the respective domain).
B: Balance; C: Coordination; P: postural control; FM: fine motor/manual dexterity.
* : Statistically significant at ($p < 0.05$) | ** : Highly significant at ($p < 0.01$) or ($p < 0.001$).
ns: Non-significant association ($p > 0.05$).
Qual: Qualitative negative association observed (descriptive case study design, (N=2)).
—: Reflex or motor domain not assessed in the study.

3.4.5 Secondary outcomes: sensory processing and school readiness

Two studies examined outcomes beyond motor performance. Retained reflex activity accompanied atypical sensory profiles in a kindergarten sample [15], and retained ATNR accompanied lower scholastic attainment in early elementary students [24] and lower attainment at the end of the first school year in a United Kingdom sample [19]. These findings are consistent in direction but rest on a small number of studies, two of which recruited children above the preschool age range, and should therefore be regarded as preliminary.

3.4.6 Consistency and heterogeneity across studies

The direction of association was consistent across all included studies: no study reported that greater retained reflex activity accompanied better motor performance. However, consistency of direction should not be mistaken for consistency of evidence. The included studies differed in age range (4–7 years), health status (typically developing versus ADHD), sample size (2 to 233 participants), and motor outcome instrument (MOT 4–6, MABC, MABC-2, sport-specific assessments). Reflex grading relied on the same rating scale in almost every study; therefore, instrument-related measurement error was shared rather than independent across the evidence base. Reported effect measures were inconsistent, with several studies reporting descriptive percentages rather than association statistics, which precluded pooling and limited any statement about the strength of the relationship. A summary of the assessment instruments used and their reported psychometric basis is provided in Table 5.

Table 5. Assessment instruments used across included studies

Instrument Name	No. of Studies Using It	Construct(s) Measured	Reported Reliability / Validity & Psychometric Evidence
INPP Primitive Reflex Assessment Battery (Sally Goddard-Blythe)	10 (All included studies)	Severity and integration status of persistent primitive reflexes (ATNR, STNR, TLR, Moro, Spinal Galant, Palmar Grasp, and Rooting).	Validity: Peer-reviewed psychometric properties for validity have not been established. This is a major methodological limitation. Reliability: Inter-rater reliability is highly operator-dependent. Studies addressed this by using a single highly experienced investigator to ensure consistency or by using a simplified 3-point scale (combining scores 1–2 and 3–4), which demonstrated 100% inter-investigator reliability during clinical rehearsal but sacrificed clinical sensitivity.
Motor Proficiency Test for Children Aged 4–6 (MOT 4–6)	4 (Pecuch, 2021; Heena, 2024 [ADHD]; Heena, 2024 [Prev]; Ewa, 2018).	Motor proficiency across 18 items representing four subdomains: stability, locomotion, object control, and fine movement.	Validity: Strong convergent validity with the Movement ABC (MABC-2) (Cools et al., 2010). Norm-referenced instrument. Reliability: High assessment protocol efficiency, high reproducibility, and excellent structural fit for preschool populations.

Movement Assessment Battery for Children (MABC-2)	2 (Andrea, 2023; Sally Goddard B, 2021).	Motor competence and risk of developmental coordination disorder (DCD) across 3 domains: Manual Dexterity, Aiming & Catching, and Balance.	Validity: Globally recognized gold standard for motor impairment diagnosis in mainstream medicine and DSM-5 alignment. Standardized on international cohorts. Reliability: Well-established, high test-retest reliability and excellent internal consistency across the target age ranges (3–16 years).
Woodcock-Johnson Tests of Cognitive Abilities / Achievement	1 (Diana, 2022).	Multi-domain academic and scholastic performance (including reading, spelling, calculation, and math problem-solving).	Validity: Rated 4 out of 5 for construct and content validity in independent reviews. Reliability: Excellent internal consistency and test-retest reliability, with sub-test coefficients ranging from .83 to .95.
Sensory Profile 2.0 (SP-2)	1 (Dr. Heena, 2024 [Prevalence]).	Pediatric sensory processing patterns (seeking, avoiding, sensitivity, registration) and sensory systems (auditory, visual, touch, movement, oral).	Validity: Standardized caregiver-questionnaire with well-established norm-referenced properties for identifying sensory processing abnormalities. Reliability: Strong internal consistency and reliability metrics as detailed in the user's manual (Dunn, 2014).
BTS G-SENSOR (Inertial Motion Sensor)	1 (Ewa G., 2022 [Gait]).	Objective spatiotemporal gait parameters (cadence, velocity, step length, support/swing phase durations).	Validity: Highly precise 16-bit triaxial accelerometer and gyroscope. Reliability: Excellent objective accuracy with an inter-instrument correlation coefficient ranging from 0.90 to 0.99 and a coefficient of variation (CV) ≤2.5%.

Discussion

4.1 Interpretation of the evidence

Of the [N] included studies, [X] reported a statistically significant inverse association between the level of retained primitive reflex activity and motor performance, [Y] reported associations in the same direction that did not reach statistical significance, and [Z] reported descriptive findings only without formal statistical testing. The association was most consistently reported for ATNR, which was examined in the largest number of studies and linked to bilateral coordination, gait symmetry, and graphomotor tasks. Evidence for TLR and for the Moro reflex rests on substantially fewer studies and, in the case of the Moro reflex, largely on a single small clinical sample.

Variation across studies corresponded broadly to differences in participant age range, health status, and outcome instrument, which suggests that apparent inconsistency reflects methodological heterogeneity at least as much as genuine variation in the underlying relationship. Notably, the studies reporting the strongest associations were also among those with the smallest samples, a pattern that in a small evidence base is compatible with selective reporting and warrants caution.

4.2 Proposed mechanisms

Persistent primitive reflexes may reflect incomplete maturation of sensorimotor integration processes involving cortical and subcortical networks. Primitive reflexes are mediated by lower brain structures, including the brainstem and spinal cord, which predominate in the newborn period [11,26]. As development proceeds, cortical control over movement increases through myelination and sensorimotor integration, and primitive reflex activity is progressively inhibited [26,27]. On this account, continued reflexive activity may constrain the emergence of selective voluntary movement and may contribute to the muscle-tone asymmetries and postural difficulties reported in the included studies, for example the asymmetrical tension associated with retained ATNR [16,19] and the postural and balance difficulties associated with retained TLR [12,20].

It should be emphasised that the neurophysiological mechanisms underlying reflex retention remain incompletely understood, that the account presented here is inferential, and that none of the included studies tested these mechanisms directly. Alternative explanations — including that retained reflex activity and motor difficulty are parallel expressions of a common underlying maturational process rather than one producing the other — are equally compatible with the cross-sectional evidence available.

4.3 Comparison with previous work

The direction of association reported here is consistent with the earlier systematic review of learning disorders, motor function and primitive reflexes in preschool children (McWhirter et al., 2024). The present review extends that work by organising findings by individual reflex and motor outcome domain, and by appraising the included studies with a design-specific instrument, which permits the strength of evidence to be differentiated across reflexes rather than treated uniformly. The finding that evidence quality is markedly uneven between ATNR and the remaining reflexes has not previously been made explicit.

4.4 Implications for pediatric physiotherapy practice

This review provides important implications for pediatric physiotherapy practice by emphasising the importance of early identification of retained primitive reflexes and their potential association with motor development difficulties. Physiotherapists may incorporate reflex assessment within developmental screening and implement individualised sensorimotor interventions to support children's motor development. Collaboration with parents and educators may support the transfer of such interventions into children's everyday environments.

It should be noted, however, that this review examined association rather than intervention effectiveness. Evidence on the efficacy of reflex-integration interventions was outside its scope and should not be inferred from these findings. Reflex assessment is best positioned as one component of broader developmental screening rather than as a stand-alone predictor of motor outcome.

Limitations

Several limitations should be considered when interpreting these findings. First, the review was not prospectively registered, which limits protection against post hoc changes to the review protocol. Second, eligibility was restricted to studies published between 2015 and 2025 in English or Indonesian, which may have excluded relevant evidence and introduces the possibility of language bias; the publication window was set a priori because of the limited number of studies available within a shorter period. Third, the heterogeneity of study designs, assessment instruments, and participant characteristics among the included studies may limit direct comparison and generalisation of findings. Fourth, most included studies graded reflex activity using the same rating scale, for which published psychometric evidence in preschool populations is limited; systematic measurement error in that instrument would propagate across the evidence base rather than average out. Fifth, the predominance of cross-sectional designs means that the temporal ordering of reflex retention and motor difficulty cannot be established, and no causal inference is possible. Sixth, sample sizes were generally small and few studies adjusted for plausible confounders such as prematurity, sex, or socioeconomic circumstances. Finally, with fewer than ten studies per outcome domain, publication bias could not be assessed formally using funnel plots or statistical tests, and its presence cannot be excluded.

Future research should prioritise prospective longitudinal designs capable of establishing temporal ordering, the use of reflex and motor assessment instruments with reported reliability and validity in preschool populations, adequately powered samples with adjustment for confounders, and controlled trials evaluating whether reflex-targeted intervention improves motor outcomes.

Contribution to global nursing practice

Nurses conducting routine child health surveillance are frequently the first health professionals to observe emerging motor difficulties in preschool-aged children. This review indicates that retained primitive reflexes are consistently associated with poorer motor performance in this age group, supporting the inclusion of structured motor observation within developmental surveillance and the timely referral of children with identified concerns to paediatric physiotherapy. The findings also support the nursing role in educating families about early motor development and in advocating for neurodevelopmental screening within primary child health services.

Conclusion

Based on the reviewed literature, persistent primitive reflex activity appears to be associated with variations in motor skills among preschool-aged children. Higher levels of retained reflex activity were associated across studies with poorer performance in balance, coordination, postural control, and bilateral integration, with the evidence strongest and most consistent for the asymmetrical tonic neck reflex. Persistent primitive reflexes may also have implications for school readiness; however, further research is required to clarify this relationship. Because the available evidence is observational and methodologically heterogeneous, these findings should be interpreted as associations rather than as evidence of a causal effect. Structured assessment of primitive reflexes within early childhood developmental screening may nonetheless support earlier identification of children who would benefit from further motor assessment and referral to paediatric physiotherapy.

Author Contribution

The first author contributed to the study design, conceptualisation, search execution, screening, data extraction, and initial manuscript drafting. The second author contributed to screening, data extraction, critical appraisal, and manuscript revision, and acted as corresponding author. Both authors approved the final version for submission.

Conflict of interest

The authors declare that they have no conflict of interest.

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