

Detecting neurodevelopmental problems using the simple parent-reported screening tool in combination with primitive reflex assessment

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Abstract

Background The Kuesioner Pra Skrining Perkembangan/KPSP (Developmental Pre-screening Questionnaire/DPsQ) is a series of questions and instructions used as a developmental screening tool for children aged 3 months to 6 years. However, the DPsQ cannot fully detect the soft signs of future neurological disorders. However, the retained primitive reflex assessment as an adjunct to the DPsQ may be useful for such detection.

Objective To determine whether assessing for retained primitive reflexes can add to the usefulness of DPsQ as a neurodevelopmental screen in children aged 1 to 5 years.

Methods This cross-sectional study included children aged 1-5 years. Developmental screening was done using the DPsQ and retained primitive reflex assessment was performed using the Institute for Neuro-Physiological Psychology (INPP) screening and scoring guideline.

Results Of 46 subjects, 56.8% of children with normal DPsQ scores had not retained primitive reflexes, while 88.9% of children with suspect DPsQ score had retained primitive reflexes. Hence, children with suspect DPsQ score had a 10.5 times higher chance of retaining primitive reflexes (OR 10.50; 95%CI 1.19 to 92.73; P=0.034). Furthermore, 66.7-77.8% of children with suspect DPsQ score had retained the Moro reflex, asymmetrical tonic neck reflex (ATNR), and symmetrical tonic neck reflex (STNR). Neither gender nor age were significantly associated with either suspect DPsQ score or the presence of retained primitive reflexes.

Conclusion The DPsQ results correlate to integration of primitive reflexes, with 10.50 greater odds of children with 'suspect' DPsQ scores to have retained primitive reflexes. As such, retained primitive reflexes is not useful as a primary screen for future neurological problems. However, a high percentage of children (43.2%) with normal DPsQ scores also have retained primitive reflexes. [Paediatr Indones. 2020;60:31-6; doi: <http://dx.doi.org/10.14238/pi60.1.2020.31-6>].

Keywords: KPSP; DPSQ; retained primitive reflex; neurodevelopmental problems; children 1-5 years old

The Kuesioner Pra Skrining Perkembangan/KPSP (Developmental Pre-screening Questionnaire/DPsQ) is a series of questions and instructions used as a developmental screening method for children aged 3 months to 6 years.¹ The DPsQ consists of 10 questions to be answered 'yes' or 'no' by parents. The DPsQ can be done in approximately 10-15 minutes. A DPsQ score of 9 or 10 indicates that the child has no impairment, while a score below 9 means that the child is suspected of having a developmental problem. Dhamayanti compared the Denver II Screening method as the gold standard to the DPsQ. Denver II Screening has high reliability (test-retest reliability=0.90 and interrater reliability=0.99). The sensitivity and specificity of DPsQ compared to Denver II were 60% and 92%, respectively.¹ A good developmental screen should have >70-80% sensitivity and specificity, which was not met by the DPsQ. With 60% sensitivity, 40% of

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children with developmental problems might not be detected by the DPsQ.¹ Therefore, in order to boost the sensitivity and specificity of DPsQ, especially in terms of detecting the soft signs of neurology disorders, we aimed to evaluate use of the retained primitive reflex assessment in combination with the DPsQ.

Primitive reflexes are automatic behavioral motor responses found early in life, which are subsequently inhibited and integrated.² Primitive reflexes are regarded as the training tool to develop voluntary movement as well as the development of many areas of the brain. As such, these reflexes are crucial in determining one's future neurodevelopment. Newborns, infants, and children react to stimuli with their primitive reflexes, either by moving toward or away from the stimulus. The development of these reflexes can determine the development of their motor system, which influences their rooting, sitting, lying down, crawling, grasping, walking, and many other movements.³⁻⁵ There are four phases of development (1) the reflexive movement phase, (2) the rudimentary movement phase, (3) the fundamental movement phase, and (4) the specialized movement phase.^{3,5}

In some cases, primitive reflexes are not inhibited nor integrated. This phenomenon may occur organically, by a neural disruption. Most often the disruption can be found in the frontal lobe of the brain, which also consists of the motor cortex. However, other studies found that primitive reflexes may have an unknown cause. This problem may arise due to the lack of external stimuli that is needed to support normal development of children. The presence of primitive reflexes can also be one of the easiest, fastest, and most specific indicators of future neurodevelopmental problems, such as attention-deficit/hyperactivity disorder (ADHD), autism, mental retardation, learning problems, and cerebral palsy.^{2,4,6-8}

Arditi noted that primitive reflexes were found in 20.2% of healthy children without ADHD, and 79.8% children with ADHD.³ There are numerous types of primitive reflexes in children, including rooting, sucking, grasping, and nucephalic reflexes. Moreover, some studies found that the five primitive reflexes: Moro, spinal galant, symmetrical tonic neck reflex (SNTR), assymetrical tonic neck reflex (ATNR), and tonic labyrinthine reflex (TLR), were closely related with one's future learning capabilities, motor development, and neurodevelopment.⁹⁻¹²

Screening for retained primitive reflexes is crucial in determining the chance of future neurodevelopmental problems, as immediate intervention and treatment can be done. Unfortunately, there is no adequate data in the assessment of retained primitive reflexes in healthy children. This study aimed to determine whether assessing for retained primitive reflexes can add to the usefulness of DPsQ as a neurodevelopmental screen in children aged 1 to 5 years.

Methods

This cross-sectional analytical study included children aged 1-5 years in Pancoran Mas, Kecamatan Lio, Depok, West Java, Indonesia and 2 villages in Bogor (Kampung Barongsang and Kampung Tapos).

Prior to the study, ethics was reviewed and approved by Universitas Indonesia Medical School/ Dr. Cipto Mangunkusumo Hospital Research Ethical Committee. Approval from the heads of the villages was attained before the assessment is conducted. Informed consent was obtained from subjects' parents/guardians.

Data were collected from 46 healthy children in Pancoran Mas, Depok on August 11, 2018 and in Bogor on May 29 and May 31, 2019. Subjects were obtained from the local *pendidikan anak usia dini*/PAUD (early childhood education), the *pos pelayanan perpadu/posyandu* (integrated healthcare service), and by door-to-door survey method. Subjects will be included in the study if they fulfilled all eligibility criteria. Inclusion criteria include (1) children aged 1-5 years old and (2) accompanied by subjects' parents/guardians. Exclusion criteria include (1) children were currently sick on the assessment day and (2) whose parents/guardians refused for the child to be screened.

Subjects underwent two assessments, the DPsQ development screening and the retained primitive reflex assessment. The DPsQ had a set of questions that were answered by parents/guardians, as well as particular instructions for the child to follow. The child's development status was defined based on scoring standards, normal for scores of 9-10 and suspect for scores 0-8.¹³ The retained primitive reflex assessment was conducted by physical examination. The child performed certain maneuvers as instructed

by the examiner. If not possible, the examiner would help the child to do the maneuvers. The assessments were done using the *Institute for Neuro Physiological Psychology* (INPP) screening test.⁴

Statistical analysis was done using *SPSS for Mac OS version 24* using primary data obtained from DP_sQ and retained primitive reflex assessments. Data analysis consisted of univariate analysis, categorical data displayed in tables to show frequency and percentage, as well as bivariate analysis, to evaluate for possible associations between the independent variable and dependent variables. Categorical variables were evaluated by Chi-square test. Non-normally distributed data was analyzed by Fischer's exact test. Results with P values <0.05 were considered to be statistically significant. Odds ratio (OR) and 95% confidence interval (CI) are indicative of the strength of association.

Results

Forty-six healthy children, 24 males and 22 females, met the inclusion criteria. The demographic characteristics of subjects are shown in **Table 1**. Of the 46 subjects, 37 children scored 9 or 10 on the DP_sQ (80.4%) and 9 children scored less than 9 (19.6%). In addition, 24 children had observable retained primitive reflexes (52.2%), as follows: Moro (12 subjects; 26.1%), spinal galant (3 subjects; 6.5%), ATNR (14 subjects; 30.4%), STNR (17 subjects; 37.0%) and TLR (0 subjects; 0%).

Table 1. Demographic characteristic of subjects (N=46)

Characteristics	n(%)
Age, years	
1-2	16 (34.8)
2-3	11 (23.9)
3-4	10 (21.7)
4-5	9 (19.6)
Gender	
Male	24 (52.5)
Female	22 (47.8)
DP _s Q score	
Normal	37 (80.4)
Suspect	9 (19.6)
Primitive reflexes	
Moro	12 (26.1)
Spinal galant	3 (6.5)
ATNR	14 (30.4)
STNR	17 (37.0)
TLR	0 (0)

ATNR=asymmetrical tonic neck reflex, STNR= symmetrical tonic neck reflex, TNR=tonic labyrinthine reflex

The most prevalent age group in which children scored suspect on DP_sQ was 3 to 4-yearsold (5/10 children) and the least prevalent was 1 to 2-years-old (1/16 children). There were 4/24 boys and 5/22 girls who scored less than 9 in DP_sQ assessment. However, there was no significant correlation between gender and suspect DP_sQ score (P=0.18). Nor were there significant correlations between age or gender and the presence of retained primitive reflexes (P=0.758), AS shown in **Table 2**.

As shown in **Table 3**, suspect DP_sQ score was significantly associated with the presence of primitive reflexes, with 8/24 of suspect DP_sQ subjects having retained primitive reflexes (OR 10.50; 95%CI 1.19 to 92.73; P=0.034) (**Table 3**).

Table 4 shows the correlations between the individual primitive reflex categories and DP_sQ scores. Children with suspect DP_sQ scores were more likely to have retained primitive reflexes than children with normal DP_sQ score. The most common primitive reflex found in children with normal DP_sQ score was STNR (10/37), while in children with suspect DP_sQ score, the percentage of subjects with STNR and Moro reflexes were equal (7/9). Spinal galant was more frequently found in children with normal DP_sQ score, however,

Table 2. Prevalence of retained primitive reflexes with age groups and gender (N=46)

Variables	Primitive reflexes		P value
	Not present (n=24)	Present (n=22)	
Age, n			
1-2 years	7	9	
2-3 years	7	4	
3-4 years	4	6	
4-5 years	6	3	
Gender, n			
Male	12	12	0.758*
Female	10	12	

*Chi-square

Table 3. Retained primitive reflexes in children with normal and suspect DP_sQ score (N=46)

Primitive reflexes	DP _s Q		OR (95%CI)	P value
	Suspect	Normal		
Present (n=24)	8	16	10.50	0.034*
Not present (n=22)	1	21	(1.19 to 92.73)	

*Fisher's exact test

the difference was not significant. Since none of the subjects had TLR, we could not evaluate it.

Table 4. Distribution of retained primitive reflexes in children with normal and suspect DP_sQ score (N= 46)

Primitive reflexes	DP _s Q		P value*
	Normal (n=37)	Suspect (n=9)	
Moro	5	7	0.000
Spinal galant	3	0	1.000
ATNR	8	6	0.039
STNR	10	7	0.008
TLR	0	0	Invalid

*Fisher's exact test

Discussion

Studies on primitive reflexes have been widely conducted on children with cerebral palsy and ADHD.^{3,14-15} However, there are few studies about retained primitive reflexes in healthy children. One such study in Poland on 35 healthy preschool children aged 4 to 6, was quite similar to our research. The mean age of subjects in their study was 4.7 years, while our study of 46 children had a mean age of 2.9 years old. They assessed for only 3 types of retained primitive reflexes (ATNR, STNR and TLR), while we assessed for 5 types (ATNR, STNR, TLR, Moro and spinal galant). They reported that 87% of boys and 89% of girls had at least one persistent primitive reflex of varying degrees. In contrast, we found that only 50% of boys and 54.5% of girls had persistent primitive reflexes.¹⁵ Some possible reasons for the difference in the frequency are different biological and intrapersonal factors that affect the integration of primitive reflexes in child development and that the examination and scoring results are dependent on the examiner's skill and bias.¹⁶

In our DP_sQ assessment, 37 children scored 9-10, 5 children scored 7-8, and 1 child scored below 7. Subjects were categorized into either the normal group (score 9-10) or the suspect group (score <9).¹ The independent variables of age and gender had no significant correlation with DP_sQ scores. An exception was the 3 to 4-years-age group, in which 50% of subjects had suspect DP_sQ scores, while the percentages of suspect DP_sQ scores in the other age groups were much lower, ranging from 6.3-11.1%.

In our 46 healthy subjects, children with low DP_sQ scores had a tendency to have retained primitive reflexes (8/9). Moreover, children with high DP_sQ scores had a slightly higher tendency to have integrated primitive reflexes (21/37).

Each retained primitive reflex has certain implications for future development of the child, with potential effects on concentration, attention, athletic capability, and other aspects.³ If the Moro reflex is not integrated, it will negatively impact concentration and focus, due to the accumulation of stimuli in the brain stem, and may manifest as hyperactivity and hypersensitivity. A retained Moro reflex can also be a very early sign of anxiety in the future.^{3,17} Furthermore, a retained spinal galant reflex can affect athletic capability, lead to an unbalanced gait, increase the risk of scoliosis, and decrease concentration, since small spinal stimuli may disturb focus and make the individual uncomfortable.^{3,18} Integrated ATNR is a sign of balanced coordination between the left and right sides. If ATNR persists, it could be a soft sign of poor hand-eye coordination affecting balance, in general, and concentration.^{3,17} The STNR regulates the balance between the upper and lower body. If it is not well integrated, a child will be unable to fully control the hand and leg while seated or when the head is flexed and extended, leading to poor focus and concentration. Lastly, retained TLR mainly leads to disturbances in balance and coordination, because flexion and extension stimulate muscle contraction and relaxation.^{3,14-15}

Primitive reflexes play a huge developmental role, assisting neonates to perform important movements. They are gradually integrated as the child develops. Mature response and integrated primitive reflexes show that the central nervous system has matured. This process consists of transitioning control from the brain stem to a more voluntary movement controlled by the brain cortex.^{9,16,19} The assessment of retained primitive reflexes serves as a screening tool to detect possible soft signs of future neurological problems. In comparison, the DP_sQ is a diagnostic tool to assess the child development. With "Yes" or "No" answers on 9 to 10 questions for each age group, this instrument can be used to evaluate the development of the child. It is used widely by many healthcare facilitators in Indonesia. We found that subjects with suspect DP_sQ scores had a high likelihood of having retained primitive reflexes (8/9 of subjects). However,

the absent of integrated primitive also correlated with a higher score of DPsQ (16/37). And based on statistical tool of Fisher's exact test, the P value is 0.034, which signifies that it is significant. Out of all samples, DPsQ can detect 7/12 persistent Moro reflex, 6/14 persistent ATNR and 7/17 STNR.

We found that of 9 healthy children with suspect DPsQ score, 7 had retained Moro reflex, 7 had STNR, and 6 had ATNR. On the other hand, of 37 healthy children with normal DPsQ score, the percentages of children with retained primitive reflexes were significantly lower, as 5/37 had retained Moro reflex, 10/37 had STNR, and 21.6% 8/37 ATNR. These data suggest that both assessments, DPsQ and INPP retained primitive reflex, can successfully be used to assess brain maturity. Such assessment of milestones is crucial to ensure the best possible development. Brain maturity is influenced by many factors and will be achieved faster if there are external stimuli from parents or caregivers and interpersonal relationships with people in their surroundings. Delayed brain maturity can lead to developmental problems, including autism, cognitive problems, mental retardation, ADHD, and cerebral palsy. A previous study found that 15% of school-age children had mild neurodevelopmental problems, mostly in coordination, fine motor skills, as well as decreased muscle tone.²⁰

The analysis of retained spinal galant and TLR were not significant and invalid, respectively. The small sample size of only 3 healthy children (8.1%) with retained spinal galant reflex likely led to a lack of significance. Since none of our subjects had retained TLR, this reflex could not be evaluated. These two reflexes may have been lacking/absent because they are typically the first two reflexes to be integrated, at approximately 3-4 months old for TLR and 3-6 months for spinal galant. Other factors may include external stimuli, adequate movement, and adequate exercise.³⁻⁴ A larger sample size is needed for more reliable results.

There were 16 healthy children with normal DPsQ score (43.2%) and at least one retained primitive reflex. Even though the DPsQ score proportionally correlated with the integration of primitive reflexes, some children still had retained primitive reflexes. Hence, retained primitive reflexes is useful for further screen, especially to screen future soft sign neurological problems. This research had several limitations, such as not evaluating other

independent variables, such as the child's behavior at school and at home, parental education, history of birth, or nutritional status, which may correlate to retained primitive reflexes and DPsQ score. Further study on the effect of suspect DPsQ score and late integration of primitive reflexes on school-aged children could also be done.

In conclusion, there was a significant association between low DPsQ scores and the presence of retained primitive reflex, and there were 10.50-higher odds of children with suspect DPsQ score to have retained primitive reflexes. The DPsQ can detect 41.2-58.3% of 3 primitive reflexes successfully assessed.

For further research, other independent variables that may affect DPsQ score and integration of primitive reflexes may also be assessed, such as parental education level, paternal occupation, birth history, attachment, cigarette exposure, and familial socioeconomic level.

Community and healthcare providers should assess for retained primitive reflexes in children more than 1 year old, especially in preschool-aged children, since retention can likely affect their future development. Parents can also assess their children for retained primitive reflexes to detect possible soft signs of neurological problems, so that early intervention can be done. Parents should be encouraged to increase the intensity of their child's exercise level, as well as provide appropriate attachment and external stimuli to induce the integration of primitive reflexes.

Conflict of Interest

None declared.

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