Original Article

Behavior Disorders in Early Childhood and Maternal Anemia History: A Cross-Sectional Study in Indonesia

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ABSTRACT

Background: Anemia is a health condition caused by genetic factors, infectious disorders, and the environment. Lead exposure increased the risk of anemia, with several sources including cigarette smoke, motor vehicle exhaust, pesticide residues, and contamination from synthetic textile dyes. Mothers with anemia frequently give birth to children who also experience the same condition, thereby disrupting growth and development and causing behavioral disorders. Therefore, this study aimed to examine the relationship between maternal anemia and behavioral disorders in early childhood in areas with high lead exposure.
Methods: A cross-sectional analysis was conducted, and samples were selected using purposive non-random sampling. This study included 16 early childhood education (PAUD) students, 16 parents, and 4 PAUD teachers. Data analysis included descriptive and correlational analyses using SPSS 23.
Results: The results showed a correlation between maternal hemoglobin levels and emotional and behavioral disorder scores (-0.508, $p < 0.05$), as well as autism risk detection (-0.610, $p < 0.05$). There was also a correlation between the pre-screening child development questionnaire and autism risk detection scores (-0.525, $p < 0.05$)..
Conclusion: Mothers with anemia tend to give birth to children who also develop the same condition. The condition disrupts growth and development in children, contributing to behavior disorders.

Keywords: Anemia; Behavior Disorder; Early Childhood.

Implications for Practice:

- Mothers with anemia tend to give birth to children who also develop the same condition. The condition disrupts growth and development in children, contributing to behavior disorders.
- Significant correlations exist between maternal hemoglobin levels and scores for emotional and behavioral disorders, as well as for autism risk detection. The analysis also correlates with pre-screening child development questionnaire scores and autism risk detection.
- Regular monitoring of growth and development is essential to ensure children achieve optimal progress during the golden age, and it can be carried out at Posyandu, PAUD, and TK. In addition, hemoglobin level examinations among women of reproductive age are crucial for preventing anemia, particularly in areas with a high risk of lead exposure.

Introduction

According to the Indonesian Basic Health Research report from 2007 to 2018, and the National Health Survey Report in 2023, the prevalence of anemia is quite high. From 2007 to 2018, the prevalence increased from 19.7% to 38.5%, 19.7% - 27.2%, and 13.1% - 20.3% in children, females, and males (aged 15 years and older), respectively (Priliani et al., 2025).

Children born to mothers with anemia diagnosed before the 31st week of pregnancy have a higher risk of autism and ADHD. This group also has a significantly higher risk of intellectual disability, compared to those born to healthy mothers. Among mothers with early onset anemia, 4.9% of children were diagnosed with autism compared to 3.5% in the healthy group. Similarly, 9.3% and 3.1% were diagnosed with ADHD and intellectual disability, compared to 7.1% and 1.3%, respectively. The risk of autism in children born to mothers with anemia was 44% higher than that in the healthy group. According to a previous study, the risk of ADHD and intellectual disability was 37% and 120% higher, respectively (Martinez-Tores, 2023).

Nutritional needs during pregnancy are greater, which is essential for maternal metabolism and fetal growth and development, including the need for iron. Correcting iron deficiency naturally begins during pregnancy. Iron status during pregnancy is a determinant of fetal growth and health (Setiyaningsih et al., 2023).

Prolonged anemia can disrupt children's growth and development, leading to failure to thrive. Several studies have shown the detrimental effects of iron deficiency, or iron deficiency without anemia, on neurocognitive development and behavior in children (Suriadi et al., 2025). In addition to nutritional factors, anemia can be caused by genetics, infectious disorders, and the environment. The pollution of lead is an environmental factor that increases the risk of anemia. Lead material is a neurotoxic agent that has not yet received attention in Indonesia. Anemia can be caused by accumulated lead exposure, which disrupts hemoglobin synthesis. Sources of lead exposure include cigarette smoke (Rosdianah et al., 2023) (Susilowati et al., 2025), motor vehicle exhaust (Susilowati et al., 2022)(Harini, 2024), synthetic textile dyes (Susilowati et al., 2025), pesticide residues (Purwati and Wimpy, 2023), and others.

Lead exposure affects the hematological system by disrupting heme synthesis and shortening the lifespan of erythrocytes, leading to anemia. It also increases the risk of anemia in females of childbearing age. In children, accumulated lead exposure increases the risk of neurotoxicity, including suboptimal IQ (Harini, 2024), emotional disorders (Susilowati et al., 2025), and ADHD (Susanti et al., 2015).

Lead element inhibits the process of hemoglobin formation by inhibiting the activity of the enzymes ALAD (Amino Levulinic Acid Dehydratase), ferrochelatase, and producing ROS (Reactive Oxygen Species), which cause hemolysis. This condition occurs when erythrocytes are destroyed more quickly due to their fragility, resulting in fewer circulating red blood cells. Consequently, the enzymes that bind iron (transferrin, hemoglobin, myoglobin, ferritin, cytochrome oxidase) and monoamine oxidase are reduced significantly (Bagaswoto et al., 2015).

The study location was a village where the majority of the population works in weaving and agriculture, with potential exposure to pesticides and synthetic dyes. Some factors of concern related to high lead exposure include synthetic dyes in the weaving process, residues from agricultural pesticides, and the school's relatively close

proximity to an interprovincial road (Dewi, 2024).

Methods

Study Design

A cross-sectional analysis was conducted, and samples were selected using purposive non-random sampling. The population was comprised of a village's early childhood education (PAUD) students. This location was selected based on the consideration that lead exposure to pesticides, synthetic fabric dyes, and motor vehicle exhaust can accumulate in the body and cause anemia in mothers, thereby increasing the risk of behavior disorders in early childhood.

Participants

This study involved a total of 36 participants, consisting of 16 early childhood education (PAUD) students, 16 parents, and 4 PAUD teachers from a village community with high potential exposure to lead through pesticide use, textile dye residues, and vehicle exhaust. The participants were selected using purposive non-random sampling based on inclusion criteria, which required that the children were actively enrolled in PAUD and that their parents were willing to participate. Data regarding maternal anemia history during pregnancy were obtained through questionnaires completed by the mothers, while teachers provided developmental assessments under the supervision of the village midwife. All participants provided informed consent prior to data collection, and confidentiality was maintained throughout the study.

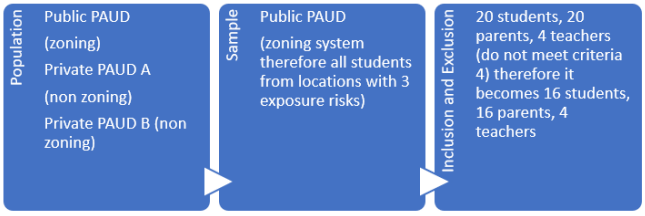

Figure 2. Sample Determination

Instruments

Several standardized instruments were used in this study to assess behavioral, developmental, and neurocognitive aspects of early childhood, as well as maternal health status. The data were collected using validated questionnaires completed by parents and teachers, along with hemoglobin measurements of mothers. Instruments for data collection included the *Screening of Preschool Psychosocial and Behavioral Problems in Indonesian Children (SPPAHI)*, *Emotional and Behavioral Problem Questionnaire (KMPE)*, *Modified Checklist for Autism in Toddlers (M-CHAT)*, *Wechsler Intelligence Scale for Children (WISC)*, and *Pre-screening Child Development Questionnaire (KPSP)*.

Parents filled out the SPPAHI and KMPE to assess children's emotional and behavioral problems. The SPPAHI demonstrated validity coefficients ranging from 0.517 to 0.910 and a reliability of 0.985, while the KMPE showed validity between 0.451 and 0.619 with a reliability coefficient of 0.9. The M-CHAT, also completed by parents, was used to detect early autism risk with a sensitivity of 82.35% and specificity of 89.68%. The WISC test, administered by a psychology assistant under the supervision of a licensed psychologist, measured children's intelligence levels, demonstrating a total internal consistency of 0.96. Developmental assessment was conducted by teachers using the KPSP, a standardized questionnaire developed by the Indonesian

Ministry of Health, under supervision from the village midwife (**Table 1**).

Table 1. Validity & Reliability Instrument (Muna et al, 2023; Ardiansyah et al, 2023; Salim et al, 2020; Tarigan & Fadillah, 2021; Nuraeny et al, 2023)

No	PIC	Instrument	Validity & Reliability		Journal Source
1	Parents fill out the questionnaire.	SPPAHI	validity 0,517-0,910	reliability 0,985	Muna et al, 2023
2	Parents fill out the questionnaire.	KMPE	validity 0,451-0,619	reliability 0,9	Ardiansyah et al, 2023
3	Parents fill out the questionnaire.	MCHAT	sensitivity 82,35%	specificity 89,68%	Salim et al, 2020
4	IQ tests are administered by a psychology assistant under the supervision of a professional psychologist.	WISC	total internal consistency 0,96		Tarigan & Fadillah, 2021
5	The questionnaire is filled out by teachers under the supervision of the village midwife.	KPSP	Kemenkes Standard Questionnaire		Nuraeny et al, 2023

Data Collection

Data collection was conducted in a village community where most residents work in weaving and agriculture. These areas are known for potential lead exposure from synthetic textile dyes, pesticide residues, and vehicle exhaust. Before data collection, ethical approval and informed consent were obtained from all participating parents and teachers. The research team coordinated with local early childhood education (PAUD) centers and village health personnel to ensure smooth implementation. Data were gathered over a defined period through direct field visits involving structured interviews, questionnaire administration, and physiological measurements.

Parents were asked to complete standardized questionnaires, including SPPAHI, KMPE, and M-CHAT, to assess their children's emotional, behavioral, and autism-related characteristics. Teachers, under the supervision of a village midwife, filled out the KPSP questionnaire to evaluate each child's developmental milestones. IQ assessments were performed using the WISC test by a psychology assistant supervised by a professional psychologist. Maternal hemoglobin levels were measured onsite using *Point-of-Care Testing (POCT)* Easy Touch test strips, ensuring rapid and accurate data collection.

Demographic data, such as the child's age, gender, maternal anemia history during pregnancy, parental occupation, and paternal smoking habits, were also recorded using a structured demographic form. The research team maintained participant confidentiality and followed standardized data recording procedures.

Data Analysis

Data analysis in this study was conducted using the Statistical Package for the Social Sciences (SPSS) version 23. Both descriptive and inferential statistical methods were applied to interpret the collected data. Descriptive statistics were used to present the distribution of participant characteristics, including the age of children and mothers, maternal hemoglobin levels, and scores from the emotional and behavioral assessments. These results were displayed in the form of means, standard deviations, and frequency distributions to provide an overview of the study population.

Inferential analysis was performed using Pearson's Product-Moment Correlation Test to determine the relationship between maternal hemoglobin levels and various child outcome variables, including emotional and behavioral disorder scores, autism risk detection, and developmental scores obtained from the pre-screening child development questionnaire (KPSP). The significance level was set at $p < 0.05$ with a 95% confidence interval. Variables that did not meet correlation assumptions were excluded from further testing. The results of these analyses were presented in tables to clearly demonstrate the strength and direction of correlations between maternal anemia and child behavioral outcomes.

Ethical Considerations

This study was approved by the Health Research Ethics Committee of Sekolah Tinggi Ilmu Kesehatan Nasional, Sukoharjo, Indonesia (Ethical Clearance No. 291/EC/KEPK/XI/2024). Ethical approval confirmed that the research protocol met all institutional and international ethical standards. All participants and their guardians were fully informed about the study objectives, procedures, potential risks, and benefits, and written informed consent was obtained prior to participation. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, ensuring confidentiality, anonymity, and voluntary participation.

Results

The descriptive analysis showed that the average age of children was 3.6 years, with the youngest and oldest being 2.1 and 4.6 years, respectively. The average age of mothers giving birth was 33 years, ranging from 24 to 50 years. Furthermore, the age of giving birth over 35 years in Indonesia was a high-risk age group. The maternal hemoglobin level at the time of data collection, which was checked using POCT and Easy Touch test strips, was at a normal level with an average of 13, ranging from 12 to 15. The average score of emotional and behavioral disorders in children was 2, with a minimum and maximum score of 0 and 6, respectively. A KMPE score of 2 was concluded to be at risk of having emotional and behavioral disorders. The average child's Autism score was 2, with 3-6 being at risk. The average ADHD score was 10, and a value of 12 was already at risk. The KPSP score averaged 8, with a minimum of 5 and a maximum of 10. Scores of 7–8 showed a need for stimulation, while values below 7 were regarded as a developmental red flag. An IQ score of 105 was considered normal, with a range of 100 to 118 classified as good (**Table 2**).

Table 2. Percentage of Normal and At-Risk Based on Children's Gender

Variable	Category	Gender	N (%)
Emotional Disorders	Normal	Male	0
		Female	2 (12.5)
	At Risk	Male	8 (50)
		Female	6 (37.5)
Autism	Normal	Male	6 (37.5)
		Female	6 (37.5)
	At Risk	Male	2 (12.5)
		Female	2 (12.5)
ADHD	Normal	Male	6 (37.5)
		Female	3 (18.75)
	At Risk	Male	2 (12.5)
		Female	5 (31.25)
Developmental Disorders	Normal	Male	5 (31.25)
		Female	4 (25)
	At Risk	Male	3 (18.75)
		Female	4 (25)

The sampling was accompanied by a supporting questionnaire that covered the children's gender, the maternal anemia history during pregnancy, the mothers' age at delivery, and the paternal smoking history. **Table 3** shows the presentation of the data from the questionnaire.

Table 3. Demographic Data of the Study Population

Variable	Category	N (%)
Children Gender	Male	8 (50)
	Female	8 (50)
Maternal Anemia History	Yes	4 (25)
	No	12 (75)
Mother's Age at Delivery	Age at Risk	7 (43)
	Productive Age	9 (57)
Paternal Smoking History	Yes	11 (69)
	No	5 (31)
Father's Occupation	Self-Employed	7 (44)
	Farmer	5 (31)
	Trader	2 (16)
	Courier	1 (6)
	Technician	1 (6)
Drinking Water Source	Well	3 (19)
	PDAM	3 (19)
	Refillable Water	10 (62)

Data on hemoglobin levels in this study were obtained through examinations conducted with a test strip and POCT Easy Touch during sample collection. Maternal anemia history referred to anemia during pregnancy and was obtained from questionnaires completed by the mothers of PAUD students. The existing data were then subjected to a correlation test using Pearson's product-moment test. **Table 4** shows the results of the correlation test between variables.

Table 4. Results of correlation tests between variables

Variable	Mean ± SD	Statistic	r	P Value
Children Age	3.6 ± 0.67	Pearson correlation test	0.555*	0.026
IQ Score	105.81 ± 6.33			
Developmental Score	8.06 ± 1.61	Pearson correlation test	-0.525*	0.037
Autism Score	2.69 ± 2.63			
Mothers Hemoglobin Level	13.45 ± 0.82	Pearson correlation test	-0.508*	0.044
Emotional Behavior Score	2.56 + 1.63			
Mothers Hemoglobin Level	13.45 + 0.82	Pearson correlation test	-0.610*	0.012
Autism Score	2.69 + 2.63			

CI 95%, *significant p < 0,05

The result showed a significant, moderate correlation between children's age and IQ score. This was because children's IQ was still developing rapidly, specifically between the ages of 3 and 5. IQ develops further when accompanied by proper stimulation and nutrition but can also be stunted in areas prone to lead exposure.

There was a significant, strong correlation between pre-screening developmental questionnaire scores and autism scores in children. This result showed that pre-screening questionnaire scores can be an indicator of autism risk and developmental disorders in children. A negative correlation implied that the higher the developmental score, the lower the children's autism score. Furthermore, there was a significant, moderate correlation between maternal hemoglobin levels and emotional behavior problems questionnaire scores. Mothers with low hemoglobin levels tended to have children with emotional behavior problems.

The analysis found a significant, moderate correlation between maternal hemoglobin levels and children's autism scores. This result showed that mothers with low hemoglobin levels tended to have children with autism and developmental disorders. Other variables measured in this study did not have significant correlations. These variables included gender, mothers' age at delivery, paternal smoking history, drinking water source, and ADHD score.

Discussion

Anemia is a global nutritional problem, specifically in developing countries. In children, anemia is characterized by insufficient red blood cells (RBCs) or hemoglobin, a type of protein that enables red blood cells to carry oxygen throughout the body. The impact of anemia on children is associated with poor health and physical development (stunting, wasting), low birth weight, intellectual retardation, and delayed motor development. These factors contribute to poor learning and work abilities, as well as increasing the risk of death and morbidity in children. Mothers with anemia were also associated with infant anemia (Risca et al., 2021). Decreased iron reserves in the brain affect enzyme synthesis and neurotransmitters, such as serotonin, dopamine, and adrenaline, which can lead to behavioral changes and reduced abilities. Low iron reserves in infants are a risk factor for iron deficiency. Furthermore, gestational age is associated with impaired children's health. A previous study showed that mothers' iron deficiency during pregnancy can lead to iron deficiency in infancy or childhood (Zulaekah et al., 2014).

In this study, children aged <12 months were at higher risk of anemia than those aged>12 months, consistent with the report. Studies in Nepal found that children from mothers with anemia were 1.99 times more likely to develop anemia (Chowdhury et al., 2020). A study in Hunan, China, found

that moderate/severe anemia in mothers was an independent risk factor for childhood anemia and significantly associated with moderate/severe anemia in children. The risk of moderate/severe anemia in children born to mothers with moderate/severe anemia increased by 133%. In general, the risk of anemia increased significantly by 77%, consistent with the report.

A cohort study conducted in India found that ferritin levels in infants born to mothers with anemia were lower than those in the healthy groups (Shukla et al., 2019). Meanwhile, observational analysis conducted in Africa explained that the percentage of anemia in children aged 6-59 months due to maternal anemia can reach 52-71% (Ntenda et al., 2018). (Akca et al., 2017) analyzed preschool children and found that children with mild anemia had an impact on nervous system development after being tested using the DDST II.

Maternal anemia during pregnancy increased the tendency to have children with behavior disorders. Micronutrient supplementation has been used to treat anemia in children, yet prevention studies provided limited evidence for a causal relationship. Supplementation may offer developmental benefits, but the effects appeared small and possibly temporary. (Chen et al., 2013).

Children with anemia tended to have lower developmental scores, predicting behavior disorder development. Differences were also observed in the activation of the auditory pathway, from the distal acoustic nerve to the lateral lemniscus, as well as in central conduction times within the nervous system. These conduction times were prolonged at 6 months of age compared with non-anemic peers, and greater differences appeared at 6 and 12 months. The delays were attributed to changes in myelination, as shown in animal models of iron deficiency. A recent study reported that children with a history of anemia also showed longer latencies in visual evoked potentials (Chen et al., 2013). Consequently, the process of understanding becomes slower, requiring additional time for information to be processed and comprehended.

A cohort study (Wiegersma et al., 2019) examined the association between anemia during pregnancy and the incidence of the most common neurodevelopmental disorders, namely autism and ADHD. Children of mothers diagnosed with anemia before 30 weeks of gestation tended to be born prematurely or small for gestational age. Meanwhile, children born to mothers diagnosed with anemia after 30 weeks of gestation tended to be born post-term or large for gestational age. Low birth weight and preterm birth were also associated with an increased risk of autism.

This study found a significant correlation between maternal hemoglobin levels and autism scores in children, with higher maternal levels showing the strongest association. Other variables, including gender, maternal age at delivery, paternal smoking history, and ADHD scores, showed no significant correlation. Children susceptible to anemia showed a tendency toward emotional, developmental, and behavioral disorders. (Chen et al., 2013). However, ADHD was only specifically correlated with iron deficiency anemia, while autism was correlated with all types of anemia.

Longitudinal studies consistently showed that children who experience anemia in early childhood continue to show poor cognitive and motor development and school performance into middle childhood. Some evidence pointed to behavioral problems and mild neurological dysfunction, but it was insufficient to identify specific cognitive deficits (Wiegersma et al., 2019). In this study, IQ scores remained within the normal range. A

significant, moderate correlation existed between the children's age and IQ scores. This is because children's IQs are still developing rapidly, specifically between the ages of 3 and 5. IQ developed further when accompanied by proper stimulation and nutrition. However, IQ has the potential to develop less optimally in areas vulnerable to pollution.

Anemia is a nutritional disorder caused by insufficient iron intake. This condition is a predisposing factor for neurocognitive decline, which triggers antisocial and aggressive behavior. Children who experience anemia at age 3 are predictors of cognitive decline and behavioral problems in school at 11 years. Several studies have shown impaired motor, cognitive, and language development, as well as poorer academic achievement in children aged 3 to 5 years with anemia. Behavioral and emotional changes contribute to the decline in cognitive and motor skills (Wiegersma et al., 2019).

The hemoglobin levels of mothers correlated with scores on the Emotional Behavior Problems Questionnaire. This shows that mothers with low hemoglobin levels correlated with children's Emotional Behavior Problems scores. Furthermore, anemia in children leads to slower physical growth, reducing health status and limiting developmental progress (Iftikhar et al., 2018).

This study found a strong and significant correlation between pre-screening developmental questionnaire scores and autism scores in children. Pre-screening questionnaire scores can be an indicator of children's risk of autism and developmental disorders.

Malnutrition in the form of iron deficiency anemia has widespread impacts, including reduced work capacity, decreased heat regulation, immune dysfunction, gastrointestinal disorders, and reduced cognitive ability (Ntenda et al., 2018). Children with malnutrition experience impaired motor development, as do those with iron deficiency anemia. Meanwhile, children with anemia have lower scores on fine motor skills, gross motor skills, and language development than those in the healthy group (Martinez-Tores et al., 2023). This result shows that anemia can impair the motor function of children.

Anemia, characterized by low hemoglobin levels, reduces the capacity of blood to transport oxygen and consequently limits delivery to the body and brain tissues. Heme iron deficiency triggers mitochondrial release of oxidants that impair various cellular functions in the brain. The neurotransmitter system is disrupted by slow myelination, decreased activity of several enzymes, and reduced density and affinity of dopamine D2 receptors. These alterations, associated with iron deficiency, tend to be responsible for impaired motor, cognitive, and behavioral performance. (Santa-Marina et al., 2020).

Anemia in children has serious consequences, ranging from decreased intelligence to increased susceptibility to mental disorders. This condition is often characterized by low hemoglobin levels due to iron deficiency. Children experience impaired concentration, poor memory, poor problem-solving skills, behavior disorders, and a lower IQ, leading to decreased academic achievement and physical abilities. Anemia disrupts enzymes in brain metabolism, interferes with myelination, and impairs cellular oxygenation.

Central conduction time is prolonged in 6-month-old children with anemia; no improvement occurs after correction. Children with anemia also have prolonged visual evoked potentials (Irsa et al., 2016).

Concentration disorders affect the ability of children to maintain attention, a skill that develops gradually over time. Severe cases are marked by difficulty

focusing, completing tasks consistently, and retaining instructions, along with frequent loss of belongings and diminished attention when interacting with parents and teachers. In developed countries, the prevalence of iron deficiency anemia among children under 4 years of age was estimated at 20.1%, increasing to 39% in developing countries. Some of the contributing factors include exposure to cigarette smoke during pregnancy, maternal anemia, and environmental lead exposure. The body's iron absorption system also absorbs lead, which subsequently inhibits iron uptake through competitive inhibition. Lead interferes with several important iron-dependent metabolic steps, such as heme biosynthesis, thereby leading to anemia (Hegazy et al., 2010).

The limitations of this study included the small sample size and the absence of controls for confounding factors, restricting the analysis to correlations between variables. Future studies at the same location could expand the sample to include PAUD, kindergartens (TK), and elementary schools (SD). This will facilitate a more comprehensive analysis in collaboration with integrated health service posts (Posyandu) for toddlers and adolescents, integrated guidance posts (Posbindu), and the village government.

Implications and limitations

The findings of this study highlight the significant relationship between maternal hemoglobin levels and children's emotional, behavioral, and developmental outcomes, indicating that maternal anemia may contribute to early neurodevelopmental and behavioral disorders. These results imply the need for regular screening of hemoglobin levels among women of reproductive age and early childhood developmental monitoring at community-based health posts (Posyandu) and early education centers (PAUD and TK), especially in areas with high environmental lead exposure. Health promotion and preventive interventions should focus on nutritional adequacy and reducing exposure to environmental toxins that may exacerbate anemia. However, this study has several limitations, including a small sample size and the absence of control for potential confounding variables such as nutritional intake and socioeconomic factors. The cross-sectional design also limits causal inference, and further longitudinal research with a larger and more diverse population is recommended to strengthen these findings.

Relevance to Practice

The results of this study are highly relevant for nursing and public health practice, particularly in preventive care for mothers and early childhood. Nurses, midwives, and community health workers play a crucial role in conducting early screening for anemia among women of reproductive age and promoting regular developmental assessments in children. Integrating maternal hemoglobin monitoring and child development evaluation into routine services at Posyandu, PAUD, and primary health centers can help identify risks early and prevent long-term behavioral or developmental issues. Educational interventions should also focus on increasing awareness about the impact of maternal anemia and environmental lead exposure on child neurodevelopment. Strengthening collaboration between healthcare providers, educators, and local authorities is essential to support holistic child growth and ensure optimal outcomes during the golden development period.

Conclusion

In conclusion, beyond genetic and nutritional factors, maternal anemia is caused by environmental exposures, such

as cigarette smoke, motor vehicle exhaust, pesticide residues, and contamination from synthetic textile dyes. Mothers with anemia tend to give birth to children who also develop the same condition. The condition disrupts growth and development in children, contributing to behavior disorders. Significant correlations exist between maternal hemoglobin levels and scores for emotional and behavioral disorders and autism risk detection. The analysis also correlates with pre-screening child development questionnaire scores and autism risk detection. Regular monitoring of growth and development is essential to ensure that children achieve optimal progress during the golden age, and it can be carried out at Posyandu, PAUD, and TK. In addition, hemoglobin level examinations among women of reproductive age are crucial for preventing anemia, particularly in areas with a high risk of lead exposure.

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CrediT Authorship Contributions Statement

Noviana Dewi: Conceptualization, Methodology, Supervision, Writing - Original Draft

Almas Awanis: Validation & Formal Analysis ADHD & Autism Developmental

Sevy Astriyana: Validation & Formal Analysis Developmental measurement

Anniez Rachmawati Musslifah: Validation & Formal Analysis IQ & Emotional measurement

Conflicts of Interest

There is no conflict of interest.

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