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Original Research

Depression in mothers and early childhood development: rural-urban disparities

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Abstract

Introduction: Maternal mental health is essential for early childhood development but is often neglected in public policy, especially in low- and middle-income countries. This study investigates the relationship between maternal depression and early childhood developmental outcomes in Indonesia, with attention to rural–urban differences.

Methods: Using data from 36,146 children aged 36–59 months from the 2018 Indonesian Basic Health Research (RISKESDAS), maternal depression was assessed with the Mini International Neuropsychiatric Interview, while child development was measured using the Early Child Development Index. Multivariate logistic regression was used to analyze the association between maternal depression and child developmental delays, stratified by urban and rural residence.

Results: The results revealed developmental delays in 10.2% of urban children and 13.1% of rural children. Children of mothers with depression had significantly higher odds of overall developmental delay (OR=1.9; 95%CI: 1.6–2.2; $p<0.001$). Stratified analysis showed that the odds of delay were higher in urban areas (OR=2.1; 95%CI: 1.7–2.6) than in rural areas (OR=1.7; 95%CI: 1.4–2.0).

Conclusion: These findings indicate that maternal depression is significantly associated with overall child development delays, with domain-specific associations observed particularly in the physical and literacy–numeracy domains, emphasizing the need for targeted mental health and child development interventions in both urban and rural settings.

Keywords

early childhood development, depression, Indonesia, mothers, rural–urban.

Introduction

Early childhood development is essential for long-term health, educational, and financial outcomes. The Early Childhood Development Index (ECDI), a standardized international tool developed by UNICEF, assesses developmental progress in children aged 3 to 5 years across multiple domains, including physical, literacy–numeracy, learning, and social–emotional domains. However, developmental delays are still prevalent in many low- and middle-income countries (LMICs), including those in South-East Asia, with regional estimates of 11% and frequently higher in underprivileged settings[1-3]. In Indonesia, the prevalence of early childhood developmental delays is 11% nationally[4]. These numbers are still higher than those usually reported in wealthy Western nations, where delays in early development frequently fall below 10%, but they are broadly comparable to estimates from neighboring countries such as Vietnam, the Philippines, and Cambodia [2,5].

Among many determinants of childhood development, mothers' mental health disorders have emerged as a critical, yet often under-addressed factor, particularly in LMICs[5]. Globally, depression affects 15–20% of women during pregnancy and postpartum[6-8], and several Asian countries have reported similar or higher rates[9]. Recent evidence shows that Indonesia continues to face a substantial burden of maternal mental health problems, with national estimates indicating that postpartum depression affects between 10% and 23% of mothers, depending on measurement tools and population characteristics[10]. Infants of depressed mothers demonstrate increased negative affect and reduced engagement[11], and is linked to adverse cognitive, emotional, and behavioral outcomes in children[4,12].

Importantly, the influence of maternal mental health is shaped by social and structural inequities, especially between rural and urban areas. Rural mothers often benefit from stronger social support but face greater poverty and limited healthcare access[13-15]. Another study pointed out that mental illness was more common in rural areas[16]. Conversely, urban mothers, despite better services, experience higher stress and social isolation[17]. In Indonesia, postpartum depression prevalence varies significantly by residence, with urban rates nearly double rural rates[10].

Despite growing national concern around mothers' mental health and child development, few studies have explored how these relationships differ geographically in Indonesia. Most analyses use aggregated data, obscuring important rural–urban differences. This study fills that gap by examining nationally representative data to inform equity-focused, context-specific interventions.

Methods

Study design and participants

The analysis is based on the Indonesian Basic Health Research 2018 data. The Basic Health Research design is cross-sectional and covers all districts in Indonesia. A two-stage sampling procedure that employs the probability proportional to size method was used for sample selection. The total number of respondents was 38,146 children aged 36–59 months.

Outcome variable

The primary outcome of this research is the ECDI. The development questionnaire to assess ECDI was adapted from the 2016 Multiple Indicator Cluster Survey (MICS) study. The ECDI is an international population-based child development measure that has been used in LMICs. It comprises 10 items about children's skills and behavior in four areas of development: physical, literacy–numeracy, learning, and social–emotional domains, with collected data based on parent/caregiver reports. These items have undergone tests, repeated validation, and analysis of data gathered in the Philippines, Kenya and Jordan. The result of this measure reflects whether children's development is on the right track in these four domains[18,19]. The four areas and 10 items are:

- *physical domain*: consists of 2 items, (1) can pick up small objects such as rocks or pencils from the floor using 2 fingertips (index and thumb), and/or (2) does not indicate that it sometimes hurts to play
- *literacy–numeracy domain (3 items)*: able to identify at least 10 letters of the alphabet; able to comprehend four common words; able to say names/know and recognize number symbols 1–10
- *learning domain (2 items)*: can follow simple commands to do something correctly and/or, when told, can do something without help
- *social–emotional domain (3 items)*: can socialize with other children; does not kick, bite, or hit other people; is not easily distracted when doing something.

All answers to each question are given a score of 0 if the answer is 'no' and 1 if the answer is 'yes'. The literacy–numeracy domain is assessed as on track if there are at least two 'yes' responses; the physical domain is considered on track if there is at least one 'yes'; the social–emotional domain is considered on track if there are at least two 'yes' responses; and learning is assessed as on -track if there is at least one 'yes' response. Any child on track with fewer than three domains is considered to be in the 'delayed' category, and those on track with more than three domains are in the 'normal/development on track' category[19].

Independent variables and confounding factors

The main independent variable in this study is depression in mothers. Depression in mothers was based on the Indonesian translation of the Mini International Neuropsychiatric Interview (MINI) instrument. The MINI instrument is a structured interview with 10 questions, which is used to evaluate psychiatric diseases listed in the *Diagnostic and Statistical Manual of Mental Diseases* IV and *International Classification of Diseases, 10th Revision*. Physicians and psychiatrists from the US and Europe collaborated to develop it[20]. A prior study found that the MINI instrument had a kappa value of 0.62, a positive predictive value of 30–60%, a negative predictive value of about 90%, and a sensitivity of 60–80% in identifying depression[21].

Depressive symptoms measured by this instrument include the respondent's condition during 2 weeks prior to taking the survey. A score of 0 was assigned to each 'no' response, and a score of 1 to each 'yes' response. If at least two 'yes' responses are given to questions 1–3 and at least two 'yes' responses are given to questions 4–10, the respondent is considered to have depression[20]. There were two categories for the depression variable 'no' and 'yes'.

The potential confounding variables come from family conditions and child variables. The potential confounding variables from child variables consist of gender (boy and girl), age (36–47 months and 48–59 months), and nutritional status of children (underweight). The potential confounding variables come from family conditions consisting of depression in fathers, parental education level, parental employment status, and economic status. Depression in fathers was explored using the MINI-depression instrument. The educational level of mothers and fathers was categorized as high (graduated with a diploma/higher education), medium (graduated from high school), low (graduated from junior high school), and no formal education (never go to school); mother's and father's employment status comprised employee, entrepreneur, farmer/sailor/labor and unemployment; family characteristics were a household's economic status, described by ownership index quintiles.

The ownership index is calculated based on household ownership of valuable things such as ownership of the house; type of walls, roof, and floor of the residence; type of water source; toilet facilities; and type of electricity supply. The ownership index was built using principal component analysis, and the economic status then divided into five quintiles, with quintile 1 as the lowest economic status and the highest at quintile 5. Type of residences are classified into urban and rural areas.

Data analysis

The overall analysis in this study involved complex sample analysis using comparative analysis of type of residence (urban and rural). The descriptive analysis was performed to describe the distribution of all variables, and presented in weighted percentages. A multivariate logistic regression test was used, focusing on the main independent variable.

A simple logistic regression analysis was performed to examine the impact of depression in mothers on ECDI adjusted by potential confounders. The confounder tests were performed. The 95% confidence intervals (CI) were also calculated. All statistical calculations for the study were carried out with the Statistical Package for the Social Sciences v21 (IBM Corp; https://www.ibm.com/products/spss-statistics).

Ethics approval

The Basic Health Research 2018 study protocol was reviewed and approved by the National Ethics Commission for Health Research, National Institute of Health Research and Development, Ministry of Health of Indonesia (no. LB.02.01/2/KE.024/2018). Respondents provided written informed consent for their involvement in this study.

Results

Table 1 shows that child characteristics were relatively consistent across urban and rural areas. The proportions of boys and girls were nearly equal in both areas. Low birth weight prevalence was slightly higher in urban areas (6.2%) than rural (5.9%). However, underweight status was more prevalent among rural children compared to those in urban areas.

The distribution of depression in mothers was slightly higher than depression in fathers across both settings. Regarding employment status, urban mothers were more likely to be employed in formal sectors. Conversely, a higher proportion of rural mothers were engaged in labor-intensive occupations such as farming or fishing, compared to those in urban areas. Unemployment rates were slightly higher among urban mothers compared to rural mothers.

Paternal employment patterns were similarly divergent. Urban fathers were more likely to be formal employees, while rural fathers were more often laborers or farmers. Entrepreneurs were more common among urban fathers than rural ones. Education levels showed substantial rural–urban disparities. Among urban mothers, 16.5% (95%CI: 15.6–17.4) had high levels of education, compared to only 7.2% (95%CI: 6.8–7.7) in rural areas. The majority of urban mothers had medium education (63.7%), while low education was more prevalent in rural areas (38.7% v 19.1% in urban). A similar pattern was seen among fathers, with 15.4% of urban fathers having high education levels, compared to 6.2% in rural settings.

Household socioeconomic status, measured by the ownership index, revealed significant disparities. Households in the highest wealth quintile (quintile 5) were more common in urban areas (26.2%) than in rural ones (9.0%), while the lowest quintile (quintile 1) was predominantly rural (28.8% v 15.9% in urban). In total, the population distribution was 54.2% urban and 45.8% rural.

Table 2 shows the ECDI and domain-specific outcomes. Its findings indicate disparities in early childhood development outcomes between urban and rural areas in Indonesia. Based on the ECDI, 10.2% (95%CI: 9.5–11.0) of children in urban areas were classified as developmentally delayed, compared to 13.1% (95%CI: 12.5–13.7) in rural areas. When data from both areas were combined, the national estimate of developmental delay was 11.5% (95%CI: 11.1–12.0).

Analysis of ECDI domains reveals notable disparities between urban and rural areas. The proportion of children with delayed learning in rural areas was higher (5.7%; 95%CI: 5.4–6.2) than for urban children (3.7%; 95%CI: 3.3–4.2), with a national average of 4.6%. Delays in the social–emotional domain were widespread in both settings, affecting 30.8% of rural and 29.6% of urban children, with a national rate of 30.1%. The physical domain showed the lowest prevalence of delay, with rural (2.3%) and urban (2.1%) rates nearly identical, and a national prevalence of 2.2%. The literacy–numeracy domain exhibited the highest developmental delay, particularly among rural children (39.3%) compared to urban children (31.7%), with a national rate of 35.2%.

These findings highlight that physical development is generally well supported across both settings. However, significant gaps exist in literacy–numeracy and social–emotional development, especially in rural areas.

The multivariable analysis (Table 3) shows that depression in mothers was strongly associated with developmental delays in children across both urban and rural settings. Children of mothers with depression had higher odds of overall developmental delay in urban areas (OR=2.1) and rural areas (OR=1.7). In the overall sample, the risk was 1.9 times greater ($p<0.001$), indicating the significant impact of maternal mental health on early child development. Regarding domain-specific outcomes, maternal depression was significantly associated with delays in the physical and literacy–numeracy domains across both residential settings. In contrast, no statistically significant associations were observed between maternal depression and delays in the learning or social–emotional domains in either urban or rural areas, suggesting domain-specific variability in the impact of maternal depression on child development.

Child's sex and age were also influential. Male children and those aged 36–47 months had significantly higher odds of overall developmental delay and delays in almost all developmental domains compared to older female peers ($p<0.001$). Underweight status showed a modest association with specific developmental domains in both settings. Maternal employment status played a role in overall developmental delay, particularly in urban areas. Children of unemployed mothers or those working as laborers had significantly higher odds of delay compared to children of employed mothers. This pattern remained significant in the pooled model.

Maternal education showed a strong gradient effect. Children of mothers with no formal education had more than twice the odds of overall developmental delay compared to those with higher education. The association was consistent across rural and urban groups.

Children living in rural areas had higher odds of overall developmental delay compared to those in urban settings (OR=1.2; $p<0.01$). However, this rural–urban disparity was mainly driven by differences in the learning and literacy–numeracy domains.

Table 1: Characteristics of urban and rural children aged 36–59 months in Indonesia

Characteristic	Variable	Urban			Rural			Urban + rural		
		Estimate	95%CI		Estimate	95%CI		Estimate	95%CI	
			Lower	Upper		Lower	Upper		Lower	Upper
Children										
Age (months)	36–47	49.9	48.7	51.1	50.4	49.5	51.4	50.1	49.4	50.9
	48–59	50.1	48.9	51.3	49.6	48.6	50.5	49.9	49.1	50.6
Gender	Male	51.4	50.2	52.6	51.6	50.7	52.5	51.5	50.7	52.3
	Female	48.6	47.4	49.8	48.4	47.5	49.3	48.5	47.7	49.3
Birth weight	Low	6.2	5.4	7.0	5.9	5.2	6.7	6.0	5.5	6.6
	Normal	93.8	93.0	94.6	94.1	93.3	94.8	94.0	93.4	94.5
Nutritional status (underweight)	Yes	16.0	15.2	16.9	21.4	20.7	22.2	18.5	17.9	19.1
	No	84.0	83.1	84.8	78.6	77.8	79.3	81.5	80.9	82.1
Parents										
Depression in mothers	Yes	10.4	9.6	11.2	10.3	9.7	10.9	10.3	9.8	10.9
	No	89.6	88.8	90.4	89.7	89.1	90.3	89.7	89.1	90.2
Depression in fathers	Yes	6.6	5.9	7.4	7.0	6.5	7.6	6.8	6.3	7.3
	No	93.4	92.6	94.1	93.0	92.4	93.5	93.2	92.7	93.7
Maternal employment	Employee	14.0	13.2	14.8	6.3	5.9	6.8	10.5	10.0	11.0
	Enterpreneur	12.5	11.7	13.3	8.3	7.8	8.9	10.6	10.1	11.1
	Farmer/sailor/laborer	14.7	13.9	15.6	32.3	31.4	33.1	22.7	22.0	23.3
	Unemployment	58.8	57.6	60.0	53.1	52.2	54.0	56.2	55.4	57.0
Paternal employment	Employee	33.3	32.0	34.6	11.7	11.1	12.4	23.5	22.7	24.3
	Enterpreneur	29.9	28.7	31.1	20.1	19.3	21.0	25.5	24.7	26.2
	Farmer/sailor/laborer	34.8	33.5	36.1	66.5	65.5	67.5	49.2	48.3	50.1
	Unemployment	2.0	1.7	2.5	1.6	1.4	1.9	1.8	1.6	2.1
Maternal level of education	High	16.5	15.6	17.4	7.2	6.8	7.7	12.3	11.8	12.8
	Medium	63.7	62.4	64.9	51.2	50.3	52.2	58.0	57.2	58.8
	Low	19.1	18.0	20.1	38.7	37.8	39.7	28.0	27.3	28.7
	No formal education	0.8	0.6%	1.0	2.8	2.6	3.1	1.7	1.6	1.9

Paternal level of education	High	15.4	14.4	16.3	6.2	5.8	6.7	11.2	10.7	11.8
	Medium	64.0	62.6	65.3	51.0	49.9	52.0	58.1	57.2	58.9
	Low	20.0	18.8	21.1	40.0	39.0	41.0	29.1	28.3	29.8
	No formal education	0.7	0.5	0.9	2.8	2.5	3.1	1.7	1.5	1.9
Household										
Ownership index	Quintile 5	26.2	25.1	27.3	9.0	8.4	9.5	18.3	17.6	19.0
	Quintile 4	19.3	18.3	20.3	18.1	17.4	18.9	18.7	18.1	19.4
	Quintile 3	20.0	19.1	21.0	20.2	19.4	20.9	20.1	19.5	20.7
	Quintile 2	18.6	17.7	19.6	23.9	23.1	24.7	21.1	20.4	21.7
	Quintile 1	15.9	15.0	16.8	28.8	28.0	29.7	21.8	21.2	22.4
Type of residence	Rural							45.8	45.2	46.3
	Urban							54.2	53.7	54.8

CI, confidence interval

Table 2: Prevalence of Early Childhood Development Index-based developmental delay and domain-specific delays in urban and rural Indonesia

Characteristic	Variable	Urban			Rural			Urban + rural		
		Estimate	95%CI		Estimate	95%CI		Estimate	95%CI	
			Lower	Upper		Lower	Upper		Lower	Upper
ECDI outcome										
	Delayed	10.2	9.5	11.0	13.1	12.5	13.7	11.5	11.1	12.0
	Developmentally on track	89.8	89.0	90.5	86.9	86.3	87.5	88.5	88.0	88.9
ECDI domain-specific outcome										
Learning	Delayed	3.7	3.3	4.2	5.7	5.4	6.2	4.6	4.3	5.0
	Developmentally on track	96.3	95.8	96.7	94.3	93.8	94.6	95.4	95.0	95.7
Social–emotional	Delayed	29.6	28.4	30.7	30.8	29.9	31.7	30.1	29.4	30.9
	Developmentally on track	70.4	69.3	71.6	69.2	68.3	70.1	69.9	69.1	70.6
Physical	Delayed	2.1	1.8	2.5	2.3	2.0	2.6	2.2	2.0	2.4
	Developmentally on track	97.9	97.5	98.2	97.7	97.4	98.0	97.8	97.6	98.0
Literacy–numeracy	Delayed	31.7	30.6	32.8	39.3	38.4	40.3	35.2	34.4	35.9
	Developmentally on track	68.3	67.2	69.4	60.7	59.7	61.6	64.8	64.1	65.6

CI, confidence interval. ECDI, Early Child Development Index

Table 3: Association between maternal depression and Early Childhood Development Index among children aged 36–59 months in urban and rural Indonesia

Characteristic	Variable	Urban					Rural					Urban + rural				
		ECDI AOR (95%CI)	Domain				ECDI AOR (95%CI)	Domain				ECDI AOR (95%CI)	Domain			
			Learning AOR (95%CI)	Physical AOR (95%CI)	Social–emotional AOR (95%CI)	Literacy–numeracy AOR (95%CI)		Learning AOR (95%CI)	Physical AOR (95%CI)	Social emotional AOR (95%CI)	Literacy–numeracy AOR (95%CI)		Learning AOR (95%CI)	Physical AOR (95%CI)	Social–emotional AOR (95%CI)	Literacy–numeracy AOR (95%CI)
Depression in mothers	Yes	2.1 (1.7–2.6)**	1.0 (0.6–1.7)	2.4 (1.5–3.5)**	1.1 (0.9–1.3)	1.8 (1.5–2.1)**	1.7 (1.4–2.0)**	0.9 (0.7–1.1)	2.3 (1.5–3.4)**	1.1 (0.9–1.2)	1.4 (1.3–1.6)**	1.9 (1.6–2.2)**	0.9 (0.7–1.2)	2.4 (1.8–3.3)**	1.1 (1.0–1.2)	1.6 (1.4–1.8)**
Gender	Male	1.2 (1.0–1.4)*	1.0 (0.7–1.3)	0.9 (0.6–1.3)	1.0 (0.9–1.1)	1.2 (1.0–1.3)1	1.3 (1.1–1.4)**	1.0 (0.8–1.1)	1.0 (0.8–1.3)	1.1 (1.0–1.2)*	1.1 (1.0–1.2)*	1.2 (1.1–1.3)**	1.0 (0.9–1.1)	0.9 (0.8–1.2)	1.1 (1.0–1.2)*	1.1 (1.1–1.2)**
Child's age (months)	36–47	1.6 (1.3–1.8)**	1.5 (1.1–1.9)*	1.6 (1.2–2.3)*	0.9 (0.8–1.0)*	2.0 (1.8–2.3)**	1.7 (1.5–1.8)**	1.6 (1.4–1.9)**	1.2 (0.9–1.5)	0.9 (0.8–1.0)*	1.8 (1.7–2.0)**	1.6 (1.4–1.8)**	1.5 (1.3–1.8)**	1.4 (1.1–1.7)*	0.9 (0.8–1.0)[1]	1.9 (1.8–2.1)**
Nutritional status	Underweight	1.2 (0.9–1.5)	1.4 (1.0–2.0)	1.4 (0.9–2.0)	1.0 (0.8–1.1)	1.2 (1.0–1.4)*	1.1 (0.9–1.3)	1.3 (1.1–1.5)*	1.6 (1.2–2.1)*	1.0 (0.9–1.1)	1.1 (1.0–1.2)*	1.2 (1.0–1.3)*	1.3 (1.1–1.6)*	1.5 (1.2–1.9)*	1.0 (0.9–1.1)	1.2 (1.1–1.3)*
Maternal employment	Employee (ref)															
	Enterpreneur	1.3 (0.9–1.8)**	0.6 (0.3–1.0)	1.0 (0.4–2.3)	1.2 (1.0–1.5)	1.2 (1.0–1.5)*	1.0 (0.7–1.5)	1.0 (0.6–1.6)*	0.7 (0.3–1.8)	0.9 (0.7–1.2)	1.0 (0.8–1.3)*	1.2 (0.9–1.6)**	0.7 (0.5–1.1)*	0.9 (0.5–1.7)	1.1 (1.0–1.4)	1.1 (1.0–1.4)**
	Farmer/sailor/laborer	2.0 (1.4–2.8)**	1.0 (0.6–1.7)	1.3 (0.6–2.9)	1.3 (1.1–1.6)	1.3 (1.1–1.6)*	1.2 (0.9–1.7)	1.3 (0.9–1.9)*	0.9 (0.4–2.1)	1.0 (0.8–1.2)	1.3 (1.1–1.6)*	1.6 (1.3–2.0)**	1.1 (0.8–1.6)*	1.1 (0.6–2.0)	1.2 (1.0–1.4)	1.4 (1.2–1.6)**
	Unemployment	1.6 (1.2–2.1)**	0.8 (0.5–1.3)	1.1 (0.5–2.1)	1.2 (1.0–1.4)	1.3 (1.1–1.5)*	1.1 (0.8–1.5)	1.0 (0.7–1.5)*	1.0 (0.4–2.1)	1.0 (0.8–1.2)	1.2 (1.0–1.5)*	1.4 (1.1–1.8)**	0.9 (0.6–1.2)*	1.0 (0.6–1.8)	1.1 (1.0–1.3)	1.3 (1.1–1.4)**

Maternal level of education	High (ref)															
	Medium	1.1 (0.9–1.5)	1.5 (0.9–2.3)*	1.8 (0.9–3.4)	1.0 (0.9–1.2)	1.1 (1.0–1.3)**	1.3 (1.0–1.7)**	0.9 (0.7–1.3)*	2.0 (1.0–1.1)*	1.1 (0.9–1.3)	1.2 (1.0–1.4)**	1.2 (0.9–1.4)**	1.2 (0.9–1.7)**	1.8 (1.1–3.0)*	1.1 (0.9–1.2)	1.1 (1.0–1.3)**
	Low	1.3 (0.9–1.7)	2.0 (1.2–3.4)*	1.6 (0.8–3.5)	1.2 (1.0–1.5)	1.4 (1.1–1.6)**	1.5 (1.2–2.0)**	1.2 (0.8–1.6)*	1.9 (0.9–3.9)*	1.0 (0.9–1.2)	1.6 (1.3–1.9)**	1.4 (1.1–1.7)**	1.6 (1.2–2.2)**	1.7 (0.9–2.9)*	1.1 (0.9–1.2)	1.4 (1.3–1.7)**
	No formal education	2.4 (1.1–5.3)	2.2 (0.7–7.0)*	1.3 (0.3–5.3)	0.9 (0.5–1.6)	2.5 (1.4–4.3)**	2.2 (1.6–3.2)**	1.6 (1.1–2.6)*	3.4 (1.5–7.8)*	1.0 (0.7–1.3)	2.2 (1.7–2.9)**	2.1 (1.5–2.9)**	2.1 (1.4–3.3)**	2.6 (1.4–5.1)*	0.9 (0.7–1.2)	2.2 (1.7–2.8)**
Type of residence	Urban (ref)															
	Rural											1.2 (1.1–1.3)*	1.4 (1.1–1.6)**	0.9 (0.8–1.3)	1.0 (1.0–1.1)	1.2 (1.2–1.4)**

p<0.05, *p*<0.01, *p*<0.001

AOR, adjusted odds ratio. CI, confidence interval. ECDI, Early Child Development Index.

Discussion

This study demonstrates the strong association between depression in mothers and early childhood developmental delay among Indonesian children aged 36–59 months, with consistent patterns observed across rural and urban contexts. Children of mothers with depression were nearly twice as likely to experience developmental delays compared to those with mentally healthy mothers. This result is consistent in both urban and rural environments, supporting earlier findings that maternal psychological health plays a significant role in determining the development of young children[22]. Maternal depression has been shown to influence child development from the prenatal to the postpartum period through pathways including altered fetal development and reduced maternal responsiveness[23]. Mothers who experience depression are more likely to have less responsive mother–infant interactions and engage in risk behaviors that could further impair early development, such as smoking, eating poorly, and being exposed to domestic abuse[24]. Stigma and restricted access to mental health care may reduce the protective effects of positive mother–child relations[25] in rural and resource-constrained areas, which will exacerbating these negative consequences.

The domain-specific findings further highlight the multidimensional nature of early childhood development. Maternal depression was significantly associated with delays in the physical and literacy–numeracy domains. The association with physical development may reflect indirect pathways, potentially mediated through undermined caregiving practices, including suboptimal feeding, reduced healthcare utilization, and inconsistent daily routines, which have been linked to maternal depressive symptoms[26,27]. Similarly, decreased mother participation in cognitive stimulating activities like reading, counting, and supervised play at home may be more sensitive to literacy–numeracy development[28].

The absence of substantial correlations in the learning and social–emotional domains suggests that variables other than maternal mental health may have a greater impact on these aspects of development. Particularly in environments where caregiving duties are shared, participation in early childhood education programs, peer contact, and support from extended family members may mitigate the possible detrimental consequences of mother depression[29].

However, because the study used a cross-sectional design, causal direction cannot be inferred. Although poorer early childhood development may be a result of maternal depression, the opposite is also conceivable: raising a child with developmental impairments may make a mother feel more psychologically distressed. As a result, rather than being causative, the associations found in this study should be seen as correlational.

Another important limitation relates to the measurement of maternal depression. Although the MINI is frequently used and has been translated into Indonesian, multiple studies indicate that its predictive validity in the Indonesian context is limited, with relatively low positive predictive values despite acceptable sensitivity and negative predictive values. Positive predictive value is the probability that someone with a positive test result actually has the disease[30]. The moderate sensitivity indicates that the instrument is capable of identifying depressive symptoms at the population level; however, the low positive predictive value reflects the well-recognized limitation of screening tools when applied in low-prevalence settings. While this limitation should be acknowledged, the use of a large, nationally representative dataset strengthens the robustness of the observed associations. Furthermore, although outcome misclassification in low-prevalence settings may inflate effect estimates, the consistent associations observed across settings support a meaningful relationship between maternal depressive symptoms and early childhood developmental outcomes.

In addition to maternal mental health, developmental results were impacted by characteristics connected to the child. Developmentally delayed children were more likely to be boys and younger (36–47 months) than girls and older (48–59 months), indicating patterns of susceptibility related to age and gender. These findings are consistent with earlier research suggesting that, compared to girls, boys are more prone to have developmental delays and vulnerabilities, especially in relation to motor skills and tracing ability[31]. A study in Ghana, Bangladesh, and Costa Rica revealed that boys exhibited development deficits of 28%, 31%, and 50%, respectively, compared to girls before the age of 5 years[32]. Recent research conducted in a multiple countries has repeatedly demonstrated that young girls perform better than boys in their early linguistic and socioemotional development. Girls outperformed boys in linguistic and social–emotional skills by 0.14 and 0.17 standard deviations, respectively, according to a comprehensive survey of children ages 7 to 48 months in nine different nations[33].

Another significant component was nutritional status; in the pooled model, underweight children had a small but substantially increased risk of developmental delay. Early childhood development is greatly impacted by malnutrition in LMICs.

Stunting and underweight are linked to poor cognitive, motor, and socioemotional skills, according to studies from Nepal and Sub-Saharan Africa[34].

Maternal education emerged as another key determinant. Children from mothers lacking formal education had nearly twice the odds of experiencing developmental delay in comparison to children whose mothers had better levels of education. Aligned with this finding, studies show that maternal education has a major effect on the development of children. Compared to children of highly educated moms, children of mothers with lower educational attainment are almost twice as likely to experience developmental delay[35]. The association between maternal education and child development is mediated by maternal understanding of child development. For example, studies show that mothers with higher education levels engage in more frequent and cognitively focused reading with their young children[36].

Contextual disparities were also evident. Children living in rural areas were at significantly higher risk of delay, even after adjusting for individual and household characteristics. This is in line with studies that found mothers in rural areas frequently encounter challenges such as restricted access to mental health care, a lack of understanding, and the persisting social stigma associated with psychological problems[37]. Those obstacles impede early detection and treatment of postpartum depression and anxiety. Thus, it highlights structural inequities, reflects broader systemic issues and stresses the necessity of context-specific, integrated treatments that target the mental health of mothers as well as more general societal factors of early child development[10].

Interestingly, while rural children had a higher prevalence of developmental delay, the effect of maternal depression on developmental delay was stronger in urban areas (OR=2.1 v 1.7 in rural areas).

This discrepancy may reflect differences in contextual stressors rather than prevalence alone. Although maternal depression is slightly more common in rural areas, its effect on developmental delay appears stronger in urban settings due to unique stressors such as time pressure, work–family conflict, and social isolation, which heighten risk of depression and anxiety of urban mothers[38,39].

Beyond these stressors at the individual level, larger structural and socioeconomic strains in urban settings may further amplify the developmental effects of maternal depression through broader structural and socioeconomic pressures. Decreased social support, increased financial stress, overcrowded housing, and limited child-friendly areas are all associated with rapid urbanization, which might hinder a child's ability to develop normally[40]. Data from an urban Brazilian study showed that parental mental illness and low social capital significantly raise the risk of socioemotional delays in early children[41]. Additionally, meta-analytic findings indicate that contextual stress and maternal internalizing symptoms consistently reduce maternal sensitivity, a crucial mechanism by which maternal distress affects early cognitive and social–emotional outcomes[42].

This study is also subject to limitations related to unmeasured confounding. Despite controlling for household wealth, paternal depression, education, and employment, several relevant determinants could not be included due to data constraints such as substance abuse, long-term family stress, intimate partner violence, and maternal physical health issues. The reported results should be regarded cautiously because this limitation may result in residual confounding.

Despite this limitation, the findings have important policy implications. Multisectoral strategies are needed, including enhancing mental health services, reducing poverty, and the development of green places. One fundamental approach to enhance mothers' mental health might be to integrate mothers' mental health screening and support services for mothers into primary healthcare services in both urban and rural areas. It could be done by mandating routine mental health screening for pregnant and postpartum women through community health centers. Specifically, in rural areas, community-based initiatives have demonstrated promise in resolving these difficulties[37]. This strategy has been beneficial in improving mothers' mental health. For example, pregnant and postpartum women who had home visits from community health professionals had considerably lower postpartum depression scores than controls, according to a meta-analysis of nine studies from Tanzania, the UK, India, South Africa, the US, and Pakistan[43]. In urban contexts, technology-based therapies, including web-based peer support and digital parenting programs, may offer scalable solutions[38]. Establishing mother-to-mother support groups to provide psychoeducation, emotional support, and parenting skills training is beneficial. Lastly, expanding the early childhood education through existing integrated health posts (*Posyandu*) in rural areas, as well as an integrated child development monitoring system, is critical to detect and address early developmental delays, particularly in vulnerable groups.

Conclusion

This study highlights the strong link between maternal depression and overall early childhood developmental delays in urban and rural settings, with notable variations across developmental domains. The findings emphasize the importance of addressing maternal mental health as an integral component of early childhood development, alongside nutritional and socioeconomic factors, particularly in resource-limited and rural contexts. Based on the observed associations, integrated mental health screening, community support, improved nutrition, and expanded early education may contribute to improve developmental outcomes for children nationwide.

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Conflicts of interest

The authors declare that there are no conflicts of interest related to this study.

AI disclosure statement

The authors used ChatGPT (OpenAI, GPT-5.2 version), Grammarly, and QuillBot to assist with language editing, grammar correction, and paraphrasing to improve clarity and readability of the manuscript. These tools were not used for study design, data collection, data analysis, interpretation of findings, or generation of data or images. All AI-assisted content was carefully reviewed, verified for accuracy, and revised as necessary by the authors. The authors take full responsibility for the content of the manuscript.

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