

Original Article

Maternal medical conditions and parenting styles as determinants of child emotional, developmental, and growth outcomes: A community-based pilot study in urban slum areas

Ernawati Ernawati^{1*}, Yohanes Firmansyah², Alexander H. Santoso³, Fransisca IR. Dewi⁴, Agustina Agustina⁴, Monika Monika⁴, Bryan A. Wijaya⁵, Diana Dinali⁵, Shirly Gunawan⁶ and Hendsun Hendsun⁷

¹Department of Public Health, Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia; ²Department of Physiology, Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia; ³Department of Nutrition, Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia; ⁴Faculty of Psychology, Universitas Tarumanagara, Jakarta, Indonesia; ⁵Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia; ⁶Department of Pharmacology, Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia; ⁷International Education College, Zhejiang Chinese Medical University, Hangzhou, China

*Corresponding author: ernawati@fk.untar.ac.id

Abstract

Children living in urban slums are exposed to intersecting biological and psychosocial vulnerabilities, yet the relative roles of maternal health and parenting in child development remain unclear. This study aimed to examine correlations of maternal health characteristics and parenting styles with child developmental, emotional-behavioral, and nutritional measures and to explore their structural relationships. A community-based cross-sectional pilot study was conducted among mother–child dyads in West Jakarta, Indonesia. Child measures included the Strengths and Difficulties Questionnaire (SDQ), Pre-Screening Developmental Questionnaire (PDQ), and nutritional-status deviation. Maternal health characteristics included blood pressure, anthropometry, body composition, hemoglobin, fasting blood glucose, uric acid, and lipid profiles. Parenting styles were assessed using the Parenting Styles and Dimensions Questionnaire (PSDQ). Spearman's rank correlation and Partial Least Squares–Structural Equation Modeling were applied. Permissive parenting was negatively correlated with hyperactivity ($r=-0.260$; $p<0.05$), while no significant correlations were observed for authoritarian or authoritative parenting. Developmental-deficit scores were positively correlated with several maternal measures, including systolic blood pressure ($r=0.401$; $p<0.01$), body weight ($r=0.340$; $p<0.01$), fasting blood glucose ($r=0.356$; $p<0.01$), and triglycerides ($r=0.299$; $p<0.05$), and negatively correlated with high-density lipoprotein ($r=-0.413$; $p<0.01$). Maternal hemoglobin was negatively correlated with emotional-problem scores ($r=-0.263$; $p<0.05$). The PLS-SEM models explained 25.2–29.6% of the variance in SDQ scores and 23.3–26.0% in PDQ developmental-deficit scores, with maternal health-related pathways showing greater consistency across models than parenting-related pathways. Maternal health characteristics were more consistently related to child developmental and emotional-behavioral measures than parenting styles in this urban-slum population. These findings support further longitudinal studies integrating maternal health and parenting factors.

Keywords: Maternal health, parenting style, child development, emotional problems, urban slum



Introduction

Child health and development remain major global public health priorities despite substantial reductions in childhood mortality over recent decades [1,2]. Developmental disabilities continue to affect millions of children and may have long-term consequences for health, education, and social functioning [3,4]. Malnutrition, particularly stunting, also remains highly prevalent in low- and middle-income countries [5], prompting increasing efforts to improve its detection and prediction using emerging analytical approaches [6]. In Asia, nutritional, developmental, and emotional problems frequently coexist. Mental health problems among children and adolescents have been widely reported [7], and maternal anemia has been associated with childhood stunting [8]. Persistent stunting has been linked to maternal nutrition, child feeding, and household sanitation [9]. Behavioral problems have also been reported among young children in Pakistan [10], and clinically relevant emotional and behavioral difficulties were documented among schoolchildren in Japan [11]. Nevertheless, evidence on children's social-emotional development in Asia remains relatively limited and methodologically heterogeneous [12].

Indonesia faces similar challenges within a setting of rapid urbanization and marked socioeconomic inequalities. Densely populated communities in West Jakarta include areas characterized by constrained housing and environmental conditions [13]. Indonesian children continue to experience a substantial burden of infectious diseases [14] together with nutritional and biochemical abnormalities reflecting the country's double burden of malnutrition [15]. Considerable attention has therefore been directed toward improving the identification and management of childhood stunting [16], including the use of machine-learning approaches to predict its prevalence [17,18]. Despite these efforts, stunting remains an important national public health concern requiring sustained prevention and intervention strategies [19].

Children living in disadvantaged urban communities may experience additional health risks despite their physical proximity to healthcare services [20]. This phenomenon has been described as an “urban penalty,” whereby socioeconomic disadvantage, overcrowding, and inadequate living conditions offset the expected health advantages of urban residence [21,22]. High child mortality and inequalities in intervention coverage among the urban poor further demonstrate that city-level averages may conceal substantial disparities [23]. Women living in slum communities may also face barriers to maternal and child health services [24], while poverty, food insecurity, and adverse household conditions contribute to childhood malnutrition [25]. Comparisons across slum, rural, and non-slum urban populations consistently demonstrate substantial health disadvantages among slum residents [26], and pronounced intraurban inequalities in child health remain evident across low- and middle-income countries [27].

Within these environments, maternal health and parenting practices may represent interconnected determinants of child outcomes. Maternal health has been associated with child growth and development in low- and middle-income countries [28], including associations between maternal mental health and child nutritional status in urban-slum populations [29]. Developmental delay among children living in slums is likewise associated with multiple maternal, household, and environmental factors [30]. Parenting quality also influences children's developmental trajectories, including in urban populations [31]. Maternal medical conditions may affect children both directly, through biological and nutritional pathways, and indirectly, by influencing caregiving capacity and parent–child interactions. Parenting styles may consequently mediate or modify the relationships between maternal health and children's developmental, behavioral, and nutritional outcomes. However, maternal medical conditions and parenting practices are rarely examined simultaneously in relation to multiple child outcomes, particularly in disadvantaged urban communities. Therefore, the aim of this study was to examine the associations of maternal medical conditions and parenting styles with emotional and behavioral problems, developmental deficits, and nutritional-status deviations among children aged 4–6 years living in an urban-slum community in West Jakarta, Indonesia. Path analysis was also used to explore the relative contributions and structural relationships of maternal medical characteristics and parenting styles with child outcomes and to develop a preliminary conceptual model for future community-based interventions.

Methods

Study design, setting, and period

A cross-sectional study involving mother–child dyads was conducted to assess the relationships between maternal medical conditions, parenting styles, and child emotional, developmental, and growth outcomes. Each participating child and their biological mother constituted one analytical dyad. The study was conducted in the Krendang area, Tambora District, West Jakarta, Indonesia, an urban slum characterized by high population density and disadvantaged socioeconomic conditions. Data were collected from August 2024 to November 2025.

Sampling technique and sample size

Participants were recruited using non-random purposive sampling because of logistical considerations and the pilot nature of the study. The minimum sample size was calculated using an approach for correlation studies. Assuming a moderate correlation coefficient ($r=0.35$), a two-sided significance level of 5% ($\alpha=0.05$), and statistical power of 80% ($\beta=0.20$), the minimum required sample size was 62 mother–child dyads. A total of 63 mother–child dyads were included in the final analysis.

Study population and eligibility criteria

The study population consisted of mothers and their children aged 4–6 years who permanently resided in the study area. Mothers were eligible if they were the biological mother of the participating child, served as the child's primary caregiver, had lived in the study area for at least six months, and agreed to undergo physical examination and blood sampling. Mothers were excluded if they were pregnant during data collection, had chronic conditions or physical limitations that prevented body composition assessment, or had conditions contraindicating blood sampling.

Children were eligible if they were aged 4–6 years, lived with their biological mother, and did not have a severe illness at the time of assessment. Children with congenital abnormalities, identified genetic disorders, recognized neurodevelopmental disorders, or chronic illnesses that could affect growth or development were excluded.

Data collection and quality assurance

Data collection was performed by trained members of the research team. Before data collection, the research team received standardized instructions regarding participant preparation, anthropometric measurements, blood pressure assessment, questionnaire administration, and blood sampling. Measurements were conducted under standardized conditions using consistent measurement techniques and anatomical landmarks. The same measurement instruments were used throughout the study period, and all procedures followed predefined protocols and manufacturers' recommendations to minimize inter-observer and procedural variability.

Questionnaires were administered using standardized instructions. Venous blood samples were collected by trained research personnel using standard venipuncture procedures after participants had fasted for at least eight hours. Point-of-care testing (POCT) devices were operated according to the respective manufacturers' instructions and were checked and maintained according to manufacturers' recommendations before use. Test strips, reagents, and other consumables were stored and handled according to the specified conditions, and expiration dates were checked before use. Measurements producing instrument errors or technically invalid results were repeated when appropriate.

Child measurements

Child anthropometric measurements included body weight and height. Body weight was measured using a SECA 760 digital scale (seca GmbH & Co. KG, Hamburg, Germany), while height was measured using a GEA-SH2 microtoise (GEA Medical, Jakarta, Indonesia). Nutritional status was evaluated using the Centers for Disease Control and Prevention (CDC) growth reference [32], including weight-for-age, height-for-age, and the ratio of actual body weight to ideal body weight. For structural modeling, nutritional status was expressed as a deviation variable to satisfy the linearity assumption. The nutritional-status deviation was

calculated as the absolute difference between 100% and the actual-to-ideal body-weight ratio. Deviations toward either undernutrition or overweight were therefore assigned positive values, with higher values indicating greater nutritional imbalance.

Children's emotional and behavioral problems were assessed using the Strengths and Difficulties Questionnaire (SDQ) [33]. The SDQ evaluates five domains: emotional symptoms, conduct problems, hyperactivity, peer relationship problems, and prosocial behavior. Each item was scored on a three-point Likert scale (0=not true, 1=somewhat true, and 2=certainly true). Four domains represent difficulties, whereas the prosocial domain represents strength [33].

Child development was assessed using the Pre-Screening Developmental Questionnaire (PDQ) provided by the Indonesian Ministry of Health [34]. The questionnaire consists of 10 age-specific binary items. For the present analysis, a developmental deficit score was generated, with higher scores representing greater developmental deficits [34].

Parenting style assessment

Parenting style was assessed using the 32-item Parenting Styles and Dimensions Questionnaire (PSDQ) [35]. Each item was rated on a five-point Likert scale ranging from 1 (never) to 5 (always). The PSDQ assesses three parenting styles: permissive, authoritarian, and authoritative. The permissive parenting scale consists of five items. Authoritarian parenting comprises three dimensions—physical coercion, non-reasoning/punitive discipline, and verbal hostility with four items in each dimension. Authoritative parenting comprises warmth and support, autonomy granting, and regulation, with five items in each dimension [35].

Maternal anthropometric, blood pressure, and body composition measurements

Maternal blood pressure was measured using an Omron HEM-8712 digital sphygmomanometer (Omron Healthcare Co., Ltd., Kyoto, Japan) according to standardized procedures. Maternal anthropometric measurements included body weight, height, and abdominal, hip, neck, calf, and mid-upper arm circumferences. Circumferences were measured using a OneMed OD235 elastic measuring tape (OneMed, Jakarta, Indonesia), while height was measured using a GEA-SH2 microtoise (GEA Medical, Jakarta, Indonesia).

Body composition was assessed using an Omron Karada Scan HBF-375 bioelectrical impedance analyzer (Omron Healthcare Co., Ltd., Kyoto, Japan). The measurements included body weight, total body fat, visceral fat, total and regional subcutaneous fat, and total and regional skeletal muscle mass.

Laboratory examination

Venous blood samples were obtained after a minimum fasting period of eight hours. All laboratory measurements were performed using POCT methods. Fasting blood glucose, hemoglobin, and uric acid levels were measured using the FORA 3-in-1 Panel (FORA Care Inc., Hsinchu, Taiwan). The lipid profile, comprising total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides, was measured using the Nesco 6-in-1 lipid panel (NESCO Medical, Indonesia).

Statistical analysis

Statistical analysis was conducted sequentially using univariate, bivariate, and multivariate structural analyses. Univariate analysis was performed to describe maternal and child characteristics. Continuous variables were summarized using the mean and standard deviation (SD) and the median and range, as appropriate, while categorical variables were summarized using frequencies and percentages. The Kolmogorov–Smirnov test was used to assess the distribution of continuous variables. Because the variables were not normally distributed, Spearman's rank correlation analysis was used to assess associations of parenting-style scores and maternal health indicators with child outcomes (child developmental deficits, emotional and behavioral outcomes, and nutritional-status deviation).

Partial Least Squares–Structural Equation Modeling (PLS-SEM) (SmartPLS GmbH, Oststeinbek, Germany) was subsequently used to examine the structural relationships among maternal medical conditions, parenting styles, and child outcomes. PLS-SEM was selected

because of the exploratory nature of the analysis, the non-normal distribution of the data, the relatively small sample size, and the objective of evaluating direct and indirect relationships within a multidimensional framework. Path coefficients (β) and coefficients of determination (R^2) were calculated to evaluate the direction and magnitude of structural relationships and the explanatory capacity of the models.

Before PLS-SEM analysis, selected variables were directionally recoded to provide a consistent risk-oriented interpretation of the path coefficients. Within the body composition construct, the skeletal muscle component was inverted so that its direction corresponded with adiposity-related risk indicators. Hemoglobin values were also inverted so that positive path coefficients represented greater risk associated with lower hemoglobin levels. Similarly, HDL and the prosocial/strength component of the SDQ were inverted to maintain consistent directionality across the respective constructs. Permissive, authoritarian, and authoritative parenting scores were retained in their original direction without inversion. All structural pathways were evaluated using a two-tailed significance level of 5%.

Results

Child and maternal characteristics

A total of 63 mother–child dyads were included and their characteristics are presented in **Table 1**. The children had a mean age of 69.29 ± 0.53 months, and 57.1% were male. Mean body weight and height were 18.80 ± 4.40 kg and 111.13 ± 5.65 cm, respectively. The mean actual-to-ideal body-weight ratio was $91.81 \pm 22.05\%$, and the mean nutritional-status deviation was 14.16 ± 15.54 . The mean PDQ score was 8.73 ± 1.57 . For the SDQ domains, mean scores were 2.62 ± 2.09 for emotional problems, 2.00 ± 1.56 for conduct problems, 3.76 ± 2.18 for hyperactivity, 2.59 ± 1.67 for peer problems, and 8.29 ± 1.45 for prosocial behavior (**Table 1**).

Table 1. Baseline demographic, anthropometric, developmental, and emotional-behavioral characteristics of participating children in the study

Variable	Mean $\pm$ SD	Median (min–max)
Age (months)	69.29 $\pm$ 0.528	72 (58–72)
Sex, n (%)		
Male	36 (57.1)	
Female	27 (42.9)	
Weight (kg)	18.80 $\pm$ 4.40	17.6 (12.3–31.2)
Height (cm)	111.13 $\pm$ 5.65	112 (99–122)
Actual-to-ideal weight ratio (%)	91.81 $\pm$ 22.05	84.76 (61.5–163.19)
Actual-to-ideal height ratio (%)	96.66 $\pm$ 4.08	96.27 (86.31–105.91)
Nutritional-status deviation	14.16 $\pm$ 15.54	11.71 (0–85.63)
Total PDQ score	8.73 $\pm$ 1.57	9 (3–10)
SDQ emotional problems	2.62 $\pm$ 2.09	3 (0–7)
SDQ conduct problems	2.00 $\pm$ 1.56	2 (0–6)
SDQ hyperactivity	3.76 $\pm$ 2.18	4 (0–8)
SDQ peer problems	2.59 $\pm$ 1.67	2 (0–7)
SDQ prosocial behavior	8.29 $\pm$ 1.45	8 (4–10)

PDQ: Pre-Screening Developmental Questionnaire; SDQ: Strengths and Difficulties Questionnaire

The mothers had a mean age of 28.81 ± 0.61 years (**Table 2**). Mean parenting-style scores were 17.11 ± 3.66 for permissive, 44.17 ± 5.79 for authoritarian, and 27.89 ± 6.78 for authoritative parenting. Mean systolic and diastolic blood pressures were 128.89 ± 23.38 and 82.79 ± 14.41 mmHg, respectively, while the mean body mass index (BMI) was 26.10 ± 5.34 kg/m². Mean total body fat was $33.36 \pm 5.23\%$, and total skeletal muscle mass was $24.05 \pm 2.30\%$. The mean hemoglobin concentration was 11.21 ± 0.20 g/dL, with substantial variability observed across fasting blood glucose and lipid measurements (**Table 2**).

Table 2. Maternal demographic, parenting, anthropometric, body composition, and metabolic characteristics

Variable	Mean $\pm$ SD	Median (min–max)
Mother's age (years)	28.81 $\pm$ 0.61	29 (20–38)
Permissive parenting style	17.11 $\pm$ 3.66	17 (7–24)

Variable	Mean±SD	Median (min–max)
Authoritarian parenting style	44.17±5.79	45 (29–53)
Authoritative parenting style	27.89±6.78	27 (16–44)
Authoritarian physical coercion	17.48±2.28	18 (12–20)
Authoritarian non-reasoning	12.83±1.70	13 (9–15)
Authoritarian verbal hostility	13.89±3.27	14 (6–19)
Authoritative warmth and support	8.43±2.51	9 (5–14)
Authoritative autonomy granting	11.14±3.33	10 (5–18)
Authoritative regulation	8.32±2.91	8 (5–16)
Systolic blood pressure (mmHg)	128.89±23.38	124 (85–216)
Diastolic blood pressure (mmHg)	82.79±14.41	83 (57–142)
Weight (kg)	60.13±12.73	59.5 (28–95)
Height (cm)	151.7±8.6	152 (104–169.5)
Abdominal circumference (cm)	82.56±10.34	83 (58–102)
Hip circumference (cm)	96.36±9.60	96 (79–118)
Upper arm circumference (cm)	28.87±4.32	29 (20–37)
Neck circumference (cm)	33.78±4.28	34 (19–45)
Calf circumference (cm)	35.59±3.38	35 (28–44)
Total body fat (%)	33.36±5.23	33.6 (20.7–44.4)
Visceral fat (%)	8.53±5.51	8 (1–30)
Body mass index (kg/m ²)	26.10±5.34	26.3 (16.5–42.4)
Total subcutaneous fat (%)	29.39±6.49	29.2 (17–43.4)
Subcutaneous fat of the trunk (%)	25.49±6.12	25.6 (12.9–41.1)
Subcutaneous fat of the upper extremities (%)	44.59±7.82	45.6 (24.3–59.5)
Subcutaneous fat of the lower extremities (%)	41.03±8.11	40.9 (24.3–57.8)
Total skeletal muscle mass (%)	24.05±2.30	23.7 (19.6–31.1)
Skeletal muscle mass of the trunk (%)	18.47±2.56	18.2 (12.6–24.1)
Skeletal muscle mass of the upper extremities (%)	25.75±5.08	25.3 (14–37.7)
Skeletal muscle mass of the lower extremities (%)	37.05±3.24	36.6 (26.4–48.4)
Hemoglobin (g/dL)	11.21±0.20	11.5 (5.4–15.60)
Fasting blood glucose (mg/dL)	92.32±33.96	85 (61–268)
Uric acid (mg/dL)	3.82±0.75	3.65 (2.7–6.6)
Total cholesterol (mg/dL)	185.49±34.62	189 (104–280)
High-density lipoprotein (mg/dL)	49.56±13.38	48 (21–84)
Low-density lipoprotein (mg/dL)	101.86±31.41	108 (41–166)
Triglycerides (mg/dL)	128.11±10.84	102 (40–472)

Correlations between parenting styles and child measures

The correlations between parenting styles and child measures are presented in **Table 3**. Permissive parenting was negatively correlated with hyperactivity scores ($r=-0.260$; $p<0.05$). No significant correlations were observed between authoritarian or authoritative parenting and developmental deficit, emotional problems, conduct problems, hyperactivity, peer problems, prosocial behavior, or nutritional-status deviation (**Table 3**).

Correlations between maternal health characteristics and child measures

The correlations between maternal health characteristics and child measures are presented in **Table 4**. Maternal health characteristics showed several significant correlations with child developmental deficits. Developmental deficit scores were positively correlated with maternal systolic blood pressure ($r=0.401$; $p<0.01$), diastolic blood pressure ($r=0.285$; $p<0.05$), body weight ($r=0.340$; $p<0.01$), abdominal circumference ($r=0.292$; $p<0.05$), hip circumference ($r=0.278$; $p<0.05$), total body fat ($r=0.303$; $p<0.05$), body mass index ($r=0.275$; $p<0.05$), total subcutaneous fat ($r=0.257$; $p<0.05$), trunk subcutaneous fat ($r=0.274$; $p<0.05$), upper-extremity subcutaneous fat ($r=0.257$; $p<0.05$), fasting blood glucose ($r=0.356$; $p<0.01$), and triglycerides ($r=0.299$; $p<0.05$). In contrast, developmental deficit scores were negatively correlated with upper-extremity skeletal muscle mass ($r=-0.267$; $p<0.05$) and high-density lipoprotein cholesterol ($r=-0.413$; $p<0.01$) (**Table 4**).

For emotional and behavioral outcomes, maternal hemoglobin was negatively correlated with emotional-problem scores ($r=-0.263$; $p<0.05$) (**Table 4**). Low-density lipoprotein cholesterol was positively correlated with conduct-problem scores ($r=0.255$; $p<0.05$) and negatively correlated with prosocial-behavior scores ($r=-0.256$; $p<0.05$). No maternal health characteristics were significantly correlated with hyperactivity or peer-problem scores (**Table 4**).

Table 3. Spearman's rank correlations between parenting styles and child developmental, emotional-behavioral, and nutritional measures

Characteristic	Developmental deficit (PDQ)	Emotional problems (SDQ)	Conduct problems (SDQ)	Hyperactivity (SDQ)	Peer problems (SDQ)	Prosocial behavior (SDQ)	Nutritional-status deviation
Permissive	-0.032	-0.044	-0.217	-0.260*	0.108	-0.032	0.050
Authoritarian	0.169	-0.222	-0.211	-0.208	-0.051	0.131	-0.208
Authoritative	-0.126	0.202	-0.157	-0.056	0.071	-0.180	0.054

PDQ: Pre-Screening Developmental Questionnaire; SDQ: Strengths and Difficulties Questionnaire

*Statistically significant at $p < 0.05$ ** Statistically significant at $p < 0.01$

Table 4. Spearman's rank correlations between maternal health characteristics and child developmental, emotional-behavioral, and nutritional measures

Characteristic	Developmental deficit (PDQ)	Emotional problems (SDQ)	Conduct problems (SDQ)	Hyperactivity (SDQ)	Peer problems (SDQ)	Prosocial behavior (SDQ)	Nutritional-status deviation
Maternal age	0.043	0.100	-0.101	0.054	0.179	-0.109	-0.045
Systolic blood pressure	0.401**	0.013	0.041	0.118	0.125	-0.036	-0.065
Diastolic blood pressure	0.285*	0.029	0.002	0.144	0.115	-0.111	0.003
Body weight	0.340**	0.054	-0.021	0.106	0.017	0.168	-0.292*
Height	0.052	-0.089	0.130	0.113	-0.018	0.085	0.077
Abdominal circumference	0.292*	0.090	-0.046	0.038	0.123	0.008	-0.123
Hip circumference	0.278*	0.069	-0.039	0.059	0.066	0.009	-0.318*
Upper-arm circumference	0.225	0.149	-0.069	-0.055	-0.040	0.180	-0.202
Neck circumference	0.194	-0.020	-0.031	0.091	-0.131	0.025	-0.233
Calf circumference	0.120	0.062	-0.134	-0.037	-0.081	0.048	-0.203
Total body fat	0.303*	0.049	-0.086	-0.111	0.068	-0.005	-0.174
Visceral fat	0.243	0.085	0.009	0.092	0.105	0.011	-0.214
Body mass index	0.275*	0.141	-0.077	0.008	0.093	0.061	-0.225
Total subcutaneous fat	0.257*	0.114	-0.117	-0.083	0.024	0.037	-0.273*
Trunk subcutaneous fat	0.274*	0.094	-0.081	-0.056	0.066	0.007	-0.238
Upper-extremity subcutaneous fat	0.257*	0.086	-0.120	-0.104	0.023	-0.007	-0.214
Lower-extremity subcutaneous fat	0.244	0.076	-0.101	-0.110	0.015	0.016	-0.229
Total skeletal muscle	-0.217	-0.074	0.043	0.019	-0.111	0.054	0.084
Trunk skeletal muscle	-0.228	-0.078	0.094	0.030	-0.131	0.037	0.186
Upper-extremity skeletal muscle	-0.267*	-0.144	0.102	0.027	-0.107	-0.004	0.217
Lower-extremity skeletal muscle	-0.105	0.013	0.017	0.096	-0.142	0.038	-0.038
Hemoglobin	0.030	-0.263*	0.235	0.094	0.060	-0.049	0.325**
Fasting blood glucose	0.356**	-0.226	0.021	0.092	0.014	-0.050	0.074
Uric acid	0.157	0.138	-0.001	0.185	0.178	0.010	-0.102
Total cholesterol	0.135	-0.041	0.145	0.052	0.220	-0.237	0.126
High-density lipoprotein	-0.413**	0.009	0.027	-0.151	-0.170	-0.214	0.034
Low-density lipoprotein	0.011	-0.093	0.255*	0.061	0.149	-0.256*	0.089
Triglycerides	0.299*	-0.055	0.043	0.020	0.164	0.102	0.129

PDQ: Pre-Screening Developmental Questionnaire; SDQ: Strengths and Difficulties Questionnaire

* Statistically significant at $p < 0.05$ ** Statistically significant at $p < 0.01$

Nutritional-status deviation was negatively correlated with maternal body weight ($r=-0.292$; $p<0.05$), hip circumference ($r=-0.318$; $p<0.05$), and total subcutaneous fat ($r=-0.273$; $p<0.05$), whereas maternal hemoglobin was positively correlated with nutritional-status deviation ($r=0.325$; $p<0.01$) (**Table 4**).

Structural relationships of maternal health and parenting styles with child outcomes

Separate PLS-SEM models were constructed for permissive, authoritarian, and authoritative parenting styles to examine structural relationships with child emotional and developmental measures. The explanatory capacity of the models was modest, with R^2 values ranging from 0.252 to 0.296 for SDQ scores and from 0.233 to 0.260 for PDQ developmental-deficit scores.

In the permissive-parenting model (**Figure 1**), 25.2% of the variance in SDQ scores and 23.3% of the variance in PDQ developmental-deficit scores were explained by the model. Permissive parenting showed a negative path coefficient with SDQ scores ($\beta=-0.349$) and a small negative path coefficient with PDQ developmental-deficit scores ($\beta=-0.030$). Maternal blood pressure showed positive path coefficients with SDQ ($\beta=0.290$) and PDQ developmental-deficit scores ($\beta=0.304$). Maternal BMI showed a negative path coefficient with SDQ scores ($\beta=-0.240$), whereas the body-composition construct showed a positive coefficient ($\beta=0.112$). The maternal lipid-profile construct showed a positive path coefficient with PDQ developmental-deficit scores ($\beta=0.197$) (**Figure 1**).

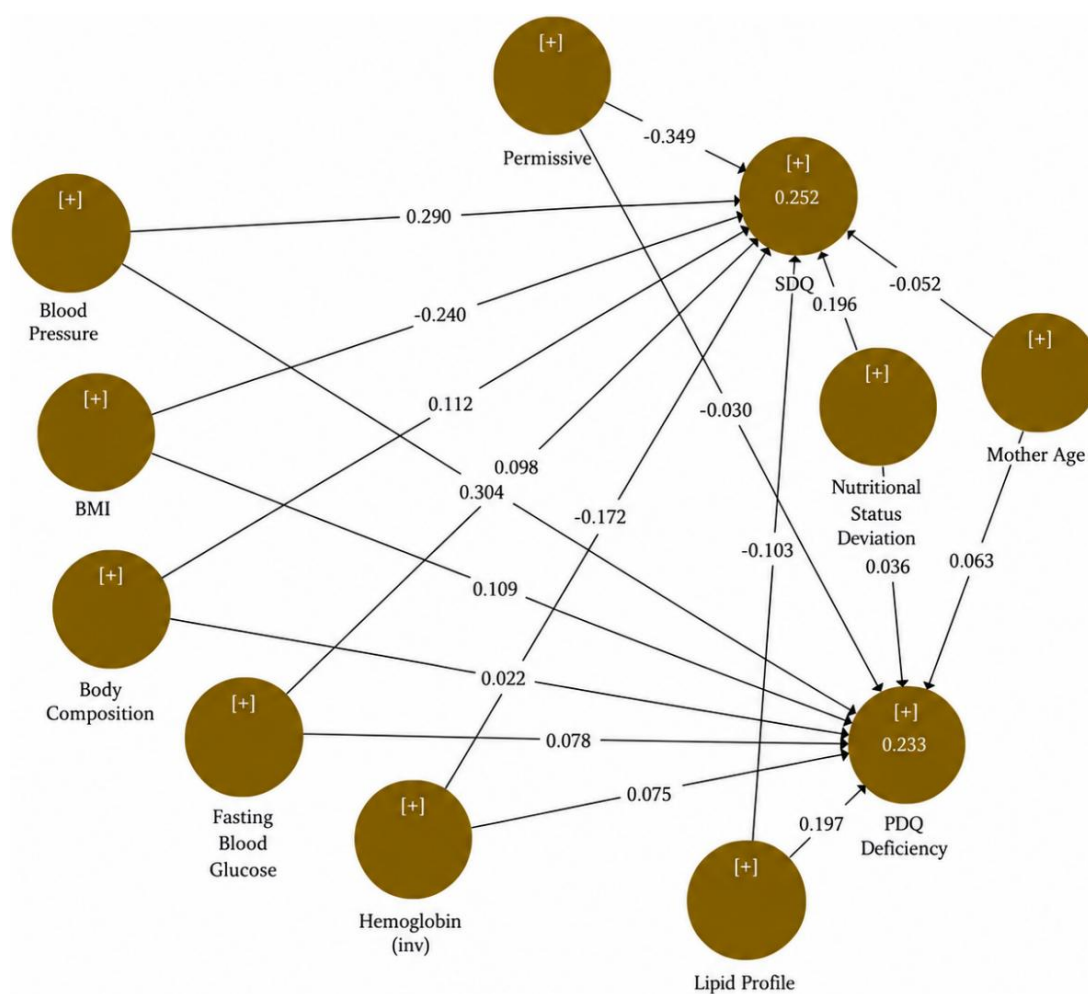


Figure 1. Path analysis model of maternal medical conditions and permissive parenting style in relation to child emotional problems (SDQ) and developmental deficiency (PDQ).

In the authoritarian-parenting model (**Figure 2**), the model explained 29.6% of the variance in SDQ scores and 26.0% of the variance in PDQ developmental-deficit scores. Authoritarian parenting showed a negative path coefficient with SDQ scores ($\beta=-0.440$) and a positive path

coefficient with PDQ developmental-deficit scores ($\beta=0.175$). Maternal blood pressure showed positive path coefficients with SDQ ($\beta=0.322$) and PDQ developmental-deficit scores ($\beta=0.271$). Maternal BMI showed a negative path coefficient with SDQ scores ($\beta=-0.353$), while the body-composition construct showed a positive coefficient ($\beta=0.369$). The maternal lipid-profile construct was positively related to PDQ developmental-deficit scores ($\beta=0.233$) (**Figure 2**).

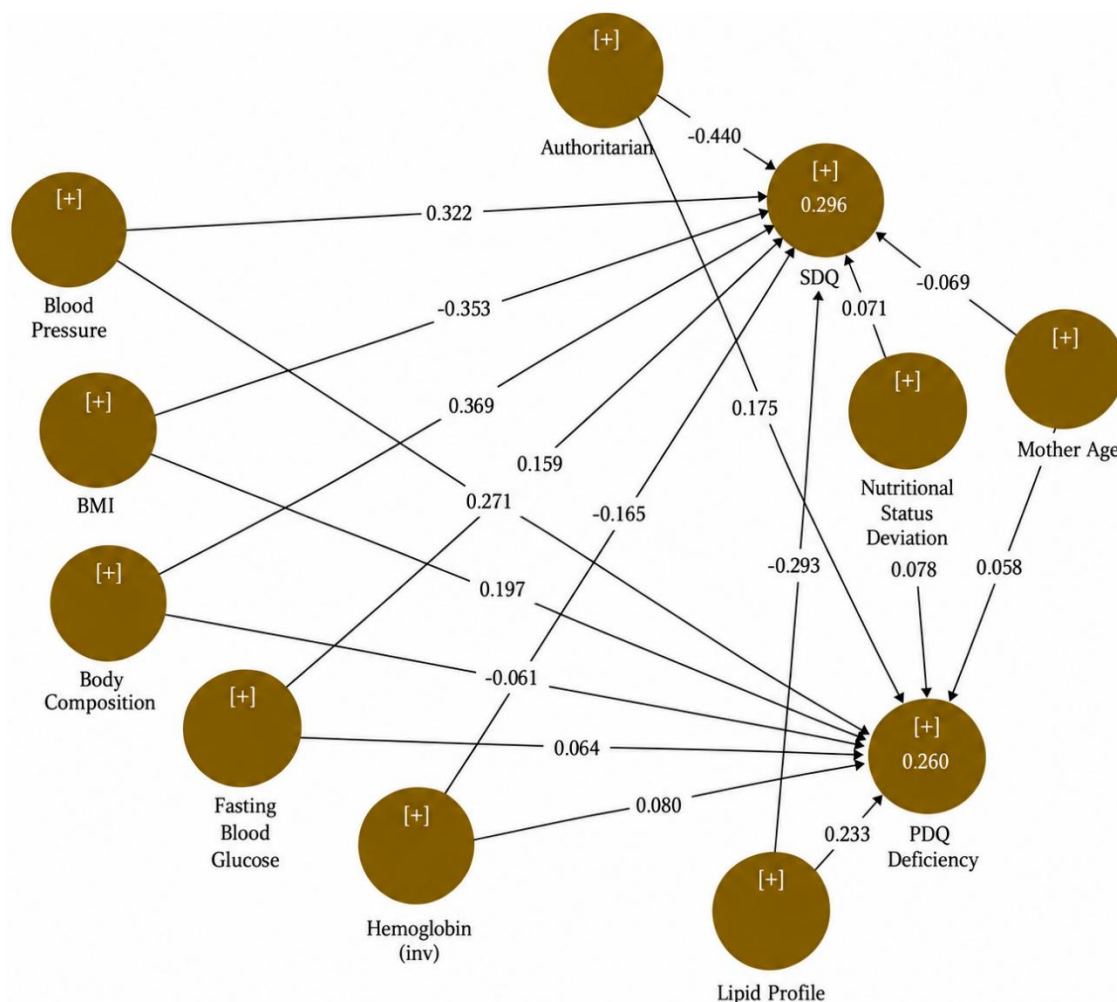


Figure 2. Path analysis model of maternal medical conditions and authoritarian parenting style in relation to child emotional problems (SDQ) and developmental deficiency (PDQ).

In the authoritative-parenting model (**Figure 3**), 25.4% of the variance in SDQ scores and 24.4% of the variance in PDQ developmental-deficit scores were explained. Authoritative parenting showed a positive path coefficient with SDQ scores ($\beta=0.318$) and with PDQ developmental-deficit scores ($\beta=0.129$). Maternal blood pressure showed positive path coefficients with SDQ ($\beta=0.263$) and PDQ developmental-deficit scores ($\beta=0.303$). Maternal BMI showed a negative path coefficient with SDQ scores ($\beta=-0.469$), whereas the body-composition construct showed a positive coefficient ($\beta=0.398$). The maternal lipid-profile construct also showed a positive path coefficient with PDQ developmental-deficit scores ($\beta=0.213$) (**Figure 3**).

Discussion

This study's findings demonstrate a nuanced relationship between maternal parenting dimensions and emotional-behavioral difficulties in early childhood, showing correlation patterns that align with prior research while also reflecting the unique contextual characteristics of Indonesia. A notable negative correlation exists between permissive parenting and child hyperactivity ($r=-0.260$; $p<0.05$), consistent with a previous study that reported that parenting mediated self-regulation, accounting for 11.28% of the indirect effect in a Chinese adolescent cohort [36].

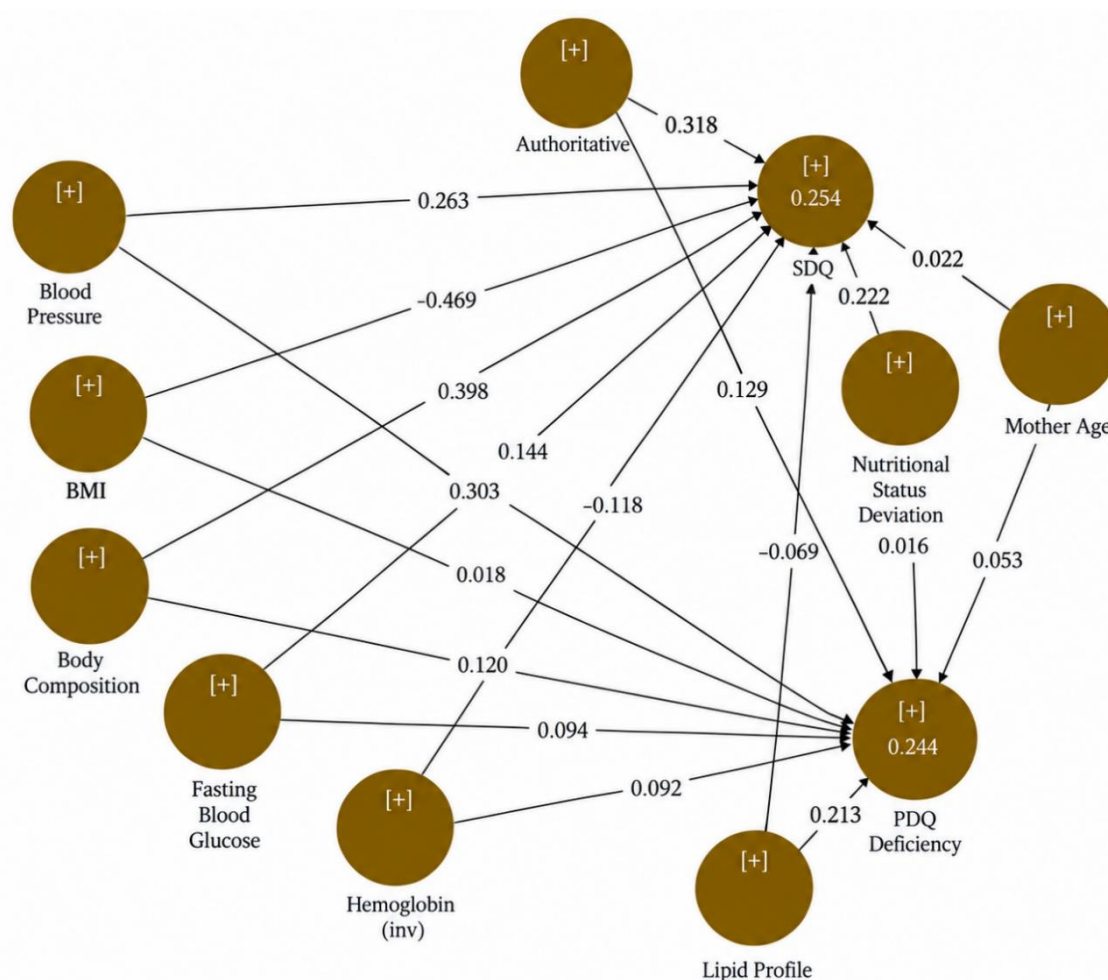


Figure 3. Path analysis model of maternal medical conditions and authoritative parenting style in relation to child emotional problems (SDQ) and developmental deficiency (PDQ).

A credible underlying mechanism is that permissive caregiving environments, despite being less structured, may alleviate psychosocial stress and improve self-regulatory capacity by fostering a heightened sense of autonomy, especially concerning hyperactivity, which may signify emotional dysregulation rather than solely conduct-related issues [36,37]. Conversely, authoritarian parenting had a negative correlation with emotional and conduct problem scores, the magnitude of these associations was rather small ($r = -0.222$ and -0.211 , respectively). This finding contrasts with prevailing paradigms in global parenting research, which consistently link authoritarian parenting to internalizing issues, anxiety, and depression in children. A systematic study in a Chinese population found that paternal and maternal rejection accounted for 11.51% of the indirect mediation effects on emotional-behavioral issues via resilience pathways [36]. The observed negative correlations with emotional problems in this study can be understood through the concept of parental authority, which distinguishes between strictness and responsiveness [36]. In the Indonesian context, authoritarian traits that prioritize clear structure and firm boundary establishment may be viewed as manifestations of protective concern rather than emotional detachment. The fundamental psychopathological mechanism may encompass cultural high-context norms, wherein adherence to parental authority diminishes emotional reactivity and anxiety by fostering predictability and clarity of expectations, thus mitigating emotional dysregulation without necessarily augmenting emotional warmth [38,39].

The present study's most notable finding is a positive correlation between authoritative parenting and children's emotional difficulties, as evidenced by the path analysis ($\beta = 0.318$; $R^2 = 0.254$), which fundamentally contradicts the prevailing global literature, which identifies authoritative parenting as the most protective style for emotional regulation [40,41]. This outcome reflects cross-cultural research by Haslam *et al.* [39] in Australia and Indonesia,

suggesting that the alignment between parenting styles and dominant cultural values may influence the efficacy of particular parenting methods; as the focus on collectivist values intensifies, the beneficial impacts of authoritative parenting on emotional outcomes may lessen or potentially invert. The mechanism of this phenomenon likely involves a cultural-parenting mismatch, where the expectations of authoritative parenting, such as autonomy, emotional expressiveness, and individual achievement may create cognitive dissonance and internal conflict in children raised in a predominantly collectivist cultural context [39].

The pathophysiological pathways potentially linking maternal blood pressure to children's emotional outcomes may involve fetal programming processes related to placental function and neurodevelopmental trajectories. In the present study, maternal systolic blood pressure showed a moderate positive correlation with children's developmental deficit scores ($r=0.401$; $p<0.01$), while path analysis demonstrated a positive association with SDQ outcomes ($\beta=0.290-0.322$). These findings are consistent with the Developmental Origins of Health and Disease framework [42,43]. Data from the All Our Families cohort reported an adjusted relative risk of 1.19 for developmental delay at 36 months among children exposed to maternal hypertension during pregnancy, providing further support for a possible association between maternal hypertensive conditions and child neurodevelopment [44]. Some biological mechanisms may plausibly contribute to this relationship. Maternal hypertension may be associated with impaired placental vascularization and endothelial function, potentially affecting oxygen and nutrient delivery to the fetus [45]. Hypoxic conditions may also influence fetal renin–angiotensin–aldosterone system (RAAS) activity and neurodevelopmental processes, while alterations in maternal cortisol levels may contribute to changes in fetal hypothalamic–pituitary–adrenal axis development. These mechanisms are biologically plausible within the fetal programming framework, although causality cannot be established from the present cross-sectional findings [43,46].

The observed association between maternal hemoglobin levels and children's emotional outcomes may reflect complex nutrient-dependent neurodevelopmental processes. Maternal hemoglobin levels were negatively correlated with children's emotional issues ($r=-0.263$; $p<0.05$), which is broadly consistent with prospective studies from Uganda and Bangladesh reporting associations between maternal anemia and poorer psychomotor and language outcomes in children [47,48]. Several mechanisms may potentially explain this relationship. Reduced oxygen-carrying capacity associated with maternal anemia may affect transplacental oxygen delivery, while iron deficiency may influence processes involved in myelination, dopamine synthesis, and mitochondrial function during brain development [49]. Anemia-related hypoxia may also be associated with activation of hypoxia-inducible factor-1 α (HIF-1 α) signaling [50]. In addition, low maternal hemoglobin may reflect broader maternal nutritional or physiological stress. These mechanisms provide biological plausibility for the observed associations, but should not be interpreted as evidence of a direct causal pathway. The positive correlation between maternal hemoglobin levels and children's nutritional status ($p=0.325$; $p<0.01$) further suggests that maternal hemoglobin may be related to nutritional conditions relevant to child growth and development [51].

The observed relationships between maternal lipid profiles and child development suggest that maternal lipid metabolism may also be relevant to fetal neurodevelopment. Maternal HDL levels were negatively correlated with children's developmental deficiency scores ($r=-0.413$; $p<0.01$), suggesting that higher HDL levels may be associated with more favorable developmental outcomes. HDL-mediated cholesterol transport may contribute to neuronal membrane integrity and myelin formation, while HDL particles may also participate in lipid transport and inflammatory regulation within the central nervous system [52,53]. These functions provide a biologically plausible basis for the observed relationship, although the present study cannot establish a direct protective effect of HDL. Similarly, higher maternal triglyceride levels were associated with greater PDQ insufficiency ($p=0.299$; $p<0.05$). Elevated triglycerides may reflect a metabolic environment characterized by increased lipid availability, oxidative stress, and inflammatory activity. Alterations in placental lipid metabolism have also been proposed as potential pathways linking maternal dyslipidemia with fetal development [54,55]. However, these mechanisms should be considered possible explanations rather than demonstrated causal pathways in the present study [52-57].

The relationship between maternal body mass index and body composition and children's emotional outcomes may also reflect interactions between maternal metabolic status and developmental environments. Maternal BMI showed a consistent negative association with SDQ scores across the models ($\beta = -0.240$ to -0.469), particularly in the authoritative parenting model. This finding suggests that maternal metabolic characteristics may be associated with child emotional outcomes within different parenting contexts. Maternal obesity is commonly accompanied by low-grade systemic inflammation, with alterations in inflammatory mediators such as interleukin-6, tumor necrosis factor- α , interleukin-1 β , and C-reactive protein. These inflammatory changes have been proposed as potential contributors to alterations in placental and fetal inflammatory environments [58,59]. Maternal adiposity may also be associated with changes in placental macrophage activity, lipid metabolism, oxidative stress, and inflammatory signaling [60]. In addition, exposure to an altered maternal metabolic environment has been hypothesized to influence fetal hypothalamic development and metabolic regulation. These mechanisms may provide biological plausibility for associations between maternal metabolic status and child emotional or behavioral outcomes [61]. The observed relationship between maternal skeletal muscle composition and SDQ scores may similarly reflect differences in glucose regulation, systemic inflammation, or overall maternal metabolic health [61]. Nevertheless, these interpretations remain hypothesis-generating given the cross-sectional design of the present study.

Evidence suggests that maternal health and metabolic conditions influence child developmental outcomes beyond psychosocial factors alone, with maternal metabolic syndrome linked to adverse developmental outcomes by early childhood [60]. Furthermore, parenting styles do not operate in isolation but within a context of nutritional, emotional, and environmental stressors where transactional models of parenting and child behavior problems have been empirically supported [62]. Theoretical frameworks such as diathesis-stress and differential susceptibility further explain that individual differences (e.g., child temperament) moderate the impact of parenting on child outcomes [63].

The biological pathways potentially linking maternal medical characteristics with children's developmental outcomes may involve interactions at the placental, metabolic, inflammatory, and epigenetic levels. Maternal hypertension, obesity, and dyslipidemia may influence placental function through different mechanisms, including vascular changes, inflammatory processes, and altered lipid metabolism [63]. These pathways may converge on changes in nutrient transfer, hormone metabolism, and immune regulation that could influence fetal neurodevelopment. Within the DOHaD framework, maternal health conditions during pregnancy may also be associated with epigenetic modifications involving DNA methylation, histone modification, and chromatin regulation, potentially affecting pathways related to stress responses, immune function, and behavior [64]. The positive correlation between maternal hemoglobin levels and child growth adequacy, together with the observed partial mediation of children's nutritional status in the relationships between maternal metabolic factors and developmental outcomes ($\beta = 0.016$ – 0.078), may indicate a possible sequential relationship between maternal health, nutritional status, and child development. However, these findings should be interpreted as associations rather than evidence of a confirmed biological sequence. Parenting styles may represent an additional contextual factor that could modify or buffer developmental trajectories, with their effects potentially influenced by cultural and socioeconomic conditions.

The practical implications of these findings support consideration of a medically integrated Community-Based Development approach [65]. Community-based programs may benefit from extending beyond parenting education to include access to maternal health assessment and monitoring, including blood pressure, hemoglobin levels, and waist circumference. The findings suggest that maternal physical health may be an important component of strategies aimed at improving developmental conditions for children [66,67]. Rather than implying that maternal health directly determines child outcomes, an integrated approach may provide an opportunity to address potentially modifiable maternal health factors alongside parenting, nutritional, and psychosocial interventions. Given the cross-sectional nature of this study, these implications should be regarded as a basis for intervention development and future longitudinal research rather than evidence of causal effects [65,67].

The principal weakness of this study is its cross-sectional design, which constrains the capacity to infer unidirectional causality. Moreover, most of the children studied were aged 5–6 years, indicating that maternal medical conditions assessed at the time of data collection may not accurately reflect maternal health status during pregnancy or early childhood, which are crucial periods for biological and neuropsychological development [68]. Thus, the identified correlations between maternal medical issues and child outcomes may indicate cumulative long-term exposures or the present health status of the mother, rather than solely prenatal influences. The study design also prevents the exclusion of reverse causality; for instance, it raises the question of whether stress associated with caring for children with emotional or developmental challenges leads to increased maternal blood pressure and metabolic issues, or conversely, whether maternal health conditions precede and influence child outcomes. Moreover, the utilization of screening instruments (SDQ and PDQ) and self-report measures for evaluating parenting practices introduces the possibility of perceptual bias, especially among mothers undergoing emotional distress who may assess their children's behaviors more unfavorably (negative reporting bias). This approach is suitable as a community-based pilot study intended to discover patterns of connection and develop a conceptual model for subsequent testing with longitudinal designs [69,70].

Nonetheless, a significant strength of this study is its holistic approach, which integrated objective biological variables, such as blood pressure, lipid profiles, and body composition evaluated by bioelectrical impedance analysis with psychosocial components. Path analysis provides a methodological benefit by clarifying intricate relational systems that basic correlation testing cannot adequately represent. This study enhances the current literature by emphasizing the particular significance of maternal physical health in marginalized urban populations, offering empirical evidence that advancements in human development quality in Indonesia are fundamentally associated with enhancements in maternal cardiometabolic health.

Conclusion

This community-based study in urban slum environments reveals that mothers' medical problems are significant structural factors of emotional challenges, developmental deficiencies, and growth disparities in children aged 4 to 6 years. Bivariate analyses and path analyses demonstrated that maternal cardiometabolic parameters—specifically blood pressure, obesity, lipid profiles, and hemoglobin status exerted more significant effects on child outcomes than changes in parenting approaches. The findings suggest that maternal biological health, likely influenced by chronic exposures from the prenatal to postnatal periods, establishes the fundamental risk framework for children's neurodevelopmental and emotional outcomes. Consequently, developmental and emotional disorders in children residing in disadvantaged urban settings should be perceived not merely as individual or psychosocial problems, but as expressions of cumulative maternal biological susceptibility.

Conversely, parental techniques acted as contextual modulators that affected the direction and intensity of children's emotional outcomes, rather than being key predictors of development and growth in this demographic. The varying impacts observed among permissive, authoritarian, and authoritative parenting styles indicate that the effectiveness of caregiving practices is substantially influenced by socioeconomic conditions and maternal health. Collectively, these findings support a paradigm shift in child health interventions in disadvantaged urban environments, from strategies focused predominantly on parenting education toward integrated community-based interventions that address maternal medical and cardiometabolic health. The structural relationships identified through path analysis provide a conceptual basis for redesigning public health interventions by prioritizing the identification, prevention, and management of maternal health problems as a fundamental component of improving outcomes in subsequent generations. This study therefore serves as a preliminary foundation for developing a Community-Based Development model in which restoration and enhancement of maternal health are positioned as essential prerequisites for optimizing children's growth, development, and emotional well-being in densely populated and marginalized urban communities.

Ethics approval

All study procedures were carried out in accordance with the ethical standards of the Declaration of Helsinki. Ethical clearance was obtained from the Universitas Tarumanagara Health Research Ethics Committee (Approval No. 016-UTHREC/UNTAR/VII/2025). Written informed consent was obtained from all participants and, where applicable, from parents or legal guardians prior to data collection.

Acknowledgments

The authors would like to express their sincere gratitude to all individuals and parties at Universitas Tarumanagara (UNTAR) who contributed to this research, from the data collection process through to the completion of the study.

Competing interests

The authors declare that there are no actual or potential conflicts of interest related to the conduct, authorship, or publication of this research.

Funding

This study was conducted without external financial support and was fully funded by the authors.

Underlying data

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

How to cite

Ernawati E, Firmansyah Y, Santoso AH, *et al.* Maternal medical conditions and parenting styles as determinants of child emotional, developmental, and growth outcomes: A community-based pilot study in urban slum areas. *Narra J* 2026; 6 (3): e3143 - <http://doi.org/10.52225/narra.v6i3.3143>.

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