

Original Article

Quality-adjusted assessment and determinants of midwife-delivered antenatal care performance in primary health services: Evidence from Indonesia

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Abstract

Indonesia continues to face a high maternal mortality rate despite improvements in maternal health service coverage. Antenatal care (ANC) performance is commonly evaluated using service coverage indicators, such as first antenatal visit (K1) and fourth antenatal visit (K4). However, these indicators do not fully capture the quality of care delivered during ANC contacts. The aim of this study was to assess ANC implementation based on the Indonesian Ministry of Health 10T Standard (10T), develop quality-adjusted performance indicators integrating coverage and service quality, and identify factors associated with midwife performance in primary health services. A cross-sectional study was conducted among village midwives in Banda Aceh, Indonesia. ANC quality was assessed using 37 indicators derived from the 10T Standard, while midwife performance was evaluated using conventional coverage indicators and newly modified quality-adjusted indicators, namely modified K1 ($K1_{mod}$) and modified K4 ($K4_{mod}$). Individual, organizational, and psychological determinants of performance were analyzed using structural equation modeling (SEM). The results indicated that conventional ANC coverage was high, with mean K1 and K4 values of 99.61% and 91.51%, respectively. However, after adjustment for 10T implementation, performance declined substantially to 84.89% for $K1_{mod}$ and 77.94% for $K4_{mod}$, indicating that coverage-based indicators overestimated actual performance. Implementation of the 10T Standard varied across components: medical identity recording ($95.4 \pm 5.7\%$), medical examination ($90.6 \pm 8.1\%$), and intervention ($87.6 \pm 10.7\%$) were relatively well implemented, whereas some components, such as counseling or health education and nutritional assessment, were less consistently performed. Key gaps were observed in nutritional assessment. SEM showed acceptable model fit (RMSEA=0.038; GFI=0.971; AGFI=0.939; TLI=0.964; CFI=0.981). Organizational factors had the strongest direct effect on midwife performance ($\beta=0.361, p<0.001$) and ANC quality ($\beta=0.310, p<0.001$), followed by individual and psychological factors. ANC quality also had a significant direct effect on midwife performance ($\beta=0.388, p<0.001$) and mediated the effects of individual, organizational, and psychological factors. These findings indicate that high ANC coverage does not necessarily reflect high-quality service delivery. Quality-adjusted indicators provide a more comprehensive measure of midwife performance, and strengthening organizational support, particularly resources, leadership, and incentives, is essential to improve ANC quality and performance in primary health services.

Keywords: Antenatal care, service quality, health service, midwife performance, SEM



Introduction

Improving the quality of maternal health services is a major public health priority, particularly in settings where maternal mortality remains high despite increasing service coverage. One of the key priorities in this effort is reducing the maternal mortality rate (MMR), maternal deaths due to pregnancy-related causes during pregnancy, childbirth, or within 42 days postpartum per 100,000 live births, which remains a major public health concern [1]. Despite a gradual decline from 390 per 100,000 live births in 1991 to 305 in 2015, Indonesia's MMR remains relatively high, indicating persistent challenges in maternal health services [1,2]. Similar challenges in reducing maternal mortality and improving antenatal care (ANC) quality are observed in other low- and middle-income countries, highlighting the persistent global burden [3,4].

ANC is a key program for monitoring pregnancy, detecting risks and complications, providing preventive interventions, and preparing women for safe childbirth and postpartum care. In Indonesia, the quality of ANC is guided by the National 10T Standard, which includes clinical examination, counseling, and intervention components. In addition to quality, ANC performance is commonly evaluated based on service utilization, particularly the frequency of antenatal visits across pregnancy trimesters [5]. The most widely used indicators are the first antenatal visit (K1) and fourth antenatal visit (K4). K1 represents the proportion of pregnant women who receive at least one antenatal visit, while K4 reflects the proportion who complete a minimum of four visits according to the recommended schedule [6].

Although K1 and K4 are useful for assessing access to and continuity of ANC, they do not adequately capture the content or quality of care delivered during ANC contacts. High coverage does not necessarily indicate that all recommended service components are provided, and reliance on coverage indicators alone may obscure gaps in counseling, nutritional assessment, risk detection, and clinical intervention. Recent studies have emphasized the need for more nuanced approaches to measuring ANC quality, particularly because service utilization and quality of care may differ substantially [7,8]. Therefore, integrating coverage and quality dimensions may provide a more accurate assessment of ANC performance.

Midwives play a central role in delivering maternal health services in Indonesia and account for a large proportion of antenatal and delivery care [9]. As frontline health providers in primary health services, village midwives are critical to the implementation of ANC standards and to the success of maternal and child health programs. Their performance is influenced by multiple factors, including individual competencies, organizational support, and psychological conditions [10]. According to Gibson's theoretical framework [11], performance is shaped by three main domains: individual factors, such as knowledge, background, and demographics; organizational factors such as resources, leadership, incentives, and work design; and psychological factors such as perception, attitude, personality, learning, and motivation. These factors interact to influence how healthcare services are delivered and ultimately affect performance outcomes (i.e., influence both the quality of ANC delivery and overall midwife performance). While midwives' competencies are important, the quality of ANC is also influenced by organizational factors. Midwives working in villages frequently experience difficulties that arise due to a lack of proper leadership, supervision, and resources, which may hinder the implementation of recommended practices [10]. Therefore, organizational factors such as leadership and resource availability are important factors of service quality and should be considered when formulating interventions to improve antenatal care.

Like most parts of Indonesia, Aceh Province has difficulties with geographical barriers, unequal distribution of medical facilities, and socio-cultural issues that could affect the use of maternal healthcare facilities. In this respect, village midwives play an important role in providing ANC to pregnant women and in early detecting any complications associated with pregnancy. Given the limitations of existing performance indicators that emphasize service coverage over quality, a more comprehensive approach is needed to evaluate midwife performance in ANC services. Therefore, the aim of this study was to assess ANC implementation based on the National 10T Standard, develop quality-adjusted performance indicators integrating coverage and service quality, and identify factors associated with midwife performance in primary health services. Specifically, this study aimed to: (1) assess the implementation of the 10T Standard in ANC

services; (2) develop formula-based composite indicators that integrate ANC coverage and quality; and (3) identify individual, organizational, and psychological factors associated with midwife performance and examine their relationships with ANC quality and midwife performance.

Methods

Study design and setting

A cross-sectional design was conducted in Banda Aceh, Aceh Province, Indonesia. Banda Aceh is the capital city of Aceh Province and is administratively divided into nine subdistricts and 90 villages, which are served by 11 primary health centers responsible for delivering maternal and child health services, including ANC. The study collected data from village midwives working in Banda Aceh in 2018. The analysis focused on ANC service delivery as documented in routine maternal health records and questionnaire-based assessment of factors related to midwife performance. The unit of analysis was the village midwife because the outcome of interest was midwife-delivered ANC performance. ANC quality was assessed using documented service components in maternal health records, while individual, organizational, and psychological determinants were measured from the midwife perspective. The cross-sectional design was considered appropriate because all study variables, including ANC quality, performance indicators, and related determinants, were assessed within the same study period.

Population and sampling

The target population consisted of all village midwives working in Aceh Province, Indonesia, in 2018, while the study sample was drawn from village midwives working in Banda Aceh. Sample size was calculated based on established guidelines [12], which recommends a minimum sample of at least five times the number of estimated parameters when applying structural equation modeling (SEM), with an optimal range of 100–300 observations for maximum likelihood estimation. Based on these considerations, a total of 105 village midwives were included, which satisfied the minimum requirements for SEM analysis. Village midwives who were actively working in Banda Aceh during the study period, involved in ANC service delivery or documentation and had available ANC service records required for performance assessment were considered eligible.

A probability sampling approach using cluster sampling was applied, with primary health centers serving as clusters. Samples were drawn proportionally to ensure representation across the study area, and all eligible midwives within selected clusters were included. The analysis was conducted at the individual level, and clustering effects were not explicitly adjusted for in the SEM analysis.

Study variables

The study variables were defined according to the specific objectives of the study. To assess the implementation of ANC based on the 10T Standard, the main variable was ANC quality. This variable was measured using indicators derived from the 10T service standards, covering medical examination, counseling, and intervention components provided during ANC.

To develop composite performance indicators integrating service coverage and quality, the main variables were conventional ANC coverage indicators and quality-adjusted performance indicators. Conventional indicators included K1 and K4 coverages. These were then combined with ANC quality based on the 10T Standard to generate modified indicators, called modified K1 ($K1_{mod}$) and modified K4 ($K4_{mod}$). Additional performance-related variables included skilled birth attendance and high-risk pregnancy detection.

To identify determinants of midwife performance, the explanatory variables were grouped into three domains based on Gibson's theoretical framework [11]: individual, organizational, and psychological factors. In the SEM analysis, individual, organizational, and psychological factors were specified as exogenous latent variables, ANC quality as an intervening variable, and midwife performance as the final outcome variable.

Measurements of antenatal care (ANC) using National 10T Standard

ANC quality was evaluated using the standardized 10T framework developed by the Indonesian Ministry of Health. The framework includes medical examination, counseling, and clinical intervention, and was used to assess the implementation of the 10T Standard in ANC services. Data were obtained from the Maternal and Child Health (MCH) Handbook and related maternal health service records documenting ANC provided by village midwives. For each midwife, ANC performance was assessed using a checklist comprising 37 indicators derived from the 10T Standard, encompassing identity documentation, anamnesis, physical examination, counseling, and intervention components. The identity documentation component included basic demographic information of the pregnant woman and her spouse. The anamnesis component covered obstetric and medical history, including the last menstrual period, estimated date of delivery, nutritional status assessment, such as mid-upper arm circumference (MUAC) and chronic energy deficiency (CED), reproductive history, and immunization status. The examination component included routine clinical assessments, such as blood pressure, body weight, gestational age, fundal height, fetal condition, and laboratory investigations. The counseling component referred to the provision of health education during antenatal visits, while the intervention component included preventive and clinical measures, such as tetanus toxoid immunization, iron supplementation, risk detection, referral practices, and initial case management. Each indicator was scored dichotomously, with a score of 1 assigned if the component was performed and 0 if it was not performed. The overall 10T Standard implementation score was calculated as the proportion of completed indicators relative to the total number of indicators assessed and was expressed as a percentage. A higher percentage indicated better implementation of the ANC standard and reflected higher quality of care delivered by the midwives.

Development and application of quality-adjusted composite indicators for midwife performance

Formula-based composite performance indicators integrating both service coverage and quality dimensions were developed. Midwife performance was assessed using four indicators: (1) K1 coverage, defined as the proportion of pregnant women who received their first antenatal visit from a skilled health provider; (2) K4 coverage, defined as the proportion of pregnant women who completed at least four antenatal visits according to the recommended schedule; (3) skilled birth attendance, defined as the proportion of deliveries assisted by trained health personnel, including midwives or physicians; and (4) high-risk pregnancy detection, defined as the identification and documentation of maternal risk factors in cohort or register records.

K1 and K4 coverages were measured as continuous variables expressed as percentages relative to the target population, in line with the national ANC coverage target of 95%. Skilled birth attendance was measured as the proportion of deliveries assisted by trained health personnel relative to the target population and was scored as 1 if the target was not achieved (<90%) and 2 if the target was achieved (≥90%). High-risk pregnancy detection was assessed based on the proportion of cases with documented risk identification in cohort records and was scored as 1 if not performed and 2 if performed.

To incorporate the quality dimension into performance assessment, K1 and K4 coverages, as quantitative indicators, were combined with ANC quality based on the 10T Standard, as the qualitative indicator. The modified indicators were calculated by multiplying conventional coverage by the percentage of 10T Standard implementation, as follows: $K1_{mod} = K1 \times 10T \text{ Standard implementation (\%)}$ and $K4_{mod} = K4 \times 10T \text{ Standard implementation (\%)}$.

These composite indicators, $K1_{mod}$ and $K4_{mod}$, were intended to provide a more comprehensive measure of midwife performance by integrating service utilization with service quality. Higher values indicated better performance in both dimensions. Differences between the conventional coverage indicators (K1 and K4) and the modified indicators ($K1_{mod}$ and $K4_{mod}$) were assessed using a mean difference test (Z-test).

Measurement of determinants of midwife performance

The determinants of midwife performance were conceptualized into three latent constructs: individual, organizational, and psychological factors. Data were collected using a structured questionnaire developed based on Gibson's theoretical framework [11].

The individual construct comprised background characteristics, demographic characteristics, and knowledge of ANC services. Background characteristics were defined according to employment status, marital status, and years of service, and were categorized as supportive if the respondent was married, a permanent employee, and had ≥ 10 years of service, and as less supportive otherwise. Demographic characteristic was represented by age, which was categorized into predefined age groups. Knowledge was assessed using 11 items, with correct responses scored as 1 and incorrect responses scored as 0, yielding a total score ranging from 0 to 11; higher scores indicated better knowledge.

The organizational construct comprised five indicators: resources, leadership, incentives, work structure, and work design. Resources indicator was assessed using two questions (items) with “yes” and “no” possible responses: availability of facilities and residence status in the assigned village. Responses were coded as 1 for “yes” and 0 for “no”. Leadership was measured using 10 items addressing supervision, guidance, and feedback. Incentives were assessed using five items, whereas work structure and work design were assessed using 5 and 12 items, respectively. These indicators reflected respondents’ perceptions of organizational support, reward systems, structural arrangements, and job design. All organizational items were measured on a 5-point Likert scale ranging from strongly disagree=1 to strongly agree=5. Scores for each indicator were calculated as the mean of the corresponding item responses, resulting in a possible range of 1 to 5, with higher scores indicating more favorable conditions.

The psychological construct comprised five indicators: perception, attitude, personality, learning, and motivation. Perception was measured using 10 items reflecting views on workload and the work environment. Attitude was assessed using five items addressing agreement with ANC standards and service practices, while personality was measured using four items representing behavioral tendencies in task performance. Learning was assessed using three items reflecting efforts to improve knowledge and skills, whereas motivation was measured using 14 items capturing internal drive and enthusiasm for work. All items within psychological construct were also measured on a 5-point Likert scale ranging from strongly disagree=1 to strongly agree=5 and the scores for each indicator were calculated as the mean, resulting in a possible range of 1 to 5, with higher scores indicating more favorable conditions. For reporting purposes, knowledge indicators were presented at the item level as frequency distributions, whereas organizational and psychological indicators were summarized at the construct level using composite scores.

Statistical analysis

Data were analyzed using descriptive and inferential statistical methods, and statistical analysis was performed in accordance with the study objectives. Descriptive statistics (mean, standard deviation (SD), minimum, and maximum values) were used to summarize respondents’ characteristics and study variables. To assess the implementation of the 10T Standard in ANC services among the midwives, the percentages for each indicator were provided. Midwife performance using conventional indicators (K_1 and K_4) and modified indicators ($K_{1\text{mod}}$ and $K_{4\text{mod}}$) was summarized using minimum, mean, and maximum values. To compare conventional and modified performance indicators (K_1 and K_4), a mean difference test (Z-test) was applied.

To identify determinants of midwife performance and to examine the relationships among individual, organizational, and psychological factors, ANC quality, and midwife performance, SEM was performed using AMOS version 8 (IBM Corp., Armonk, NY, USA). The analysis followed a two-step approach consisting of measurement model evaluation and structural model testing.

Confirmatory factor analysis (CFA) was first conducted to assess construct validity, and indicators with standardized factor loadings < 0.50 were excluded from the final measurement model. Model estimation was performed using the maximum likelihood method based on the covariance matrix [12]. Before model estimation, assumptions of normality, outliers, and multicollinearity were evaluated.

Model fit was assessed using multiple goodness-of-fit indices, including Chi-squared (χ^2), root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), Tucker–Lewis index (TLI), and comparative fit index (CFI). Values of $\text{RMSEA} \leq 0.08$ and GFI , AGFI , TLI , and $\text{CFI} \geq 0.90$ were considered indicative of acceptable model fit. Following the initial estimation, model modification was undertaken based on

modification indices while maintaining theoretical justification. Direct and indirect effects were then interpreted to evaluate the structural relationships among variables.

Results

Participants characteristics

A total of 105 village midwives were included in the study and their characteristics are presented in **Table 1**. Most respondents were aged 31–35 years (49.5%) or 36–40 years (45.7%), whereas only a small proportion were aged <30 years (1.9%) or >40 years (2.9%). Nearly all respondents were married (99.0%). In terms of employment status, most midwives were non-permanent employees or contract staff (69.5%), while 30.5% were civil servants. The majority had worked for at least 10 years (77.1%), indicating substantial professional experience among the study participants (**Table 1**).

Table 1. Characteristics of village midwives in Banda Aceh included in the study (n=105)

Characteristic	Frequency	Percentage
Age (years)		
<30	2	1.9
31–35	52	49.5
36–40	48	45.7
>40	3	2.9
Marital status		
Married	104	99.0
Unmarried	1	1.0
Employment status		
Non-permanent employee/contract	73	69.5
Civil servant	32	30.5
Years of service (years)		
<10	24	22.9
≥10	81	77.1

Antenatal care performance of midwives using National 10T Standard

The assessment of ANC services was conducted using the National 10T Standard, which consisted of three main aspects: medical, counseling, and intervention, with a total of 37 indicators (**Table 2**). Overall, variation in the implementation of ANC components was observed across indicators (**Table 2**). The identity component, part of medical aspect, had the highest level of implementation (mean±SD: 95.4±5.7%), followed by examination (90.6±8.1%) and intervention (87.6±10.7%), whereas the anamnesis component showed lower implementation (78.7±15.1%). Counseling or health education had the lowest implementation rate, with only 57.1% of midwives providing this component during ANC (**Table 2**).

Table 2. Performance of antenatal care (ANC) services based on implementation of 10T Standard by village midwives in Banda Aceh, Indonesia

Aspect	Indicator	Implementation (%)
Medical – identity	Mean±SD	95.4±5.7
	Mother's name	100.0
	Husband's name	99.0
	Mother's age	97.1
	Husband's age	87.6
	Mother's education	86.7
	Mother's occupation	99.0
	Husband's occupation	98.1
Medical – anamnesis	Mean±SD	78.7±15.1
	First day of last menstrual period	100.0
	Estimated date of delivery	100.0
	Mid-upper arm circumference (MUAC)	79.0
	Chronic energy deficiency (CED) status	57.1
	Height measurement	74.3
	Blood group	64.8
	Previous contraceptive use	73.3
	History of illness	61.0

Aspect	Indicator	Implementation (%)
Medical – examination	Allergy history	60.0
	Number of living children	96.2
	History of stillbirth	93.3
	Birth spacing	84.4
	Tetanus immunization status	86.7
	Previous birth attendant	86.7
	Mode of previous delivery	63.8
	Mean±SD	90.6±8.1
	Current complaints	83.8
	Blood pressure	78.1
	Weight measurement	97.1
	Gestational age	97.1
	Fundal height	98.1
	Fetal position	98.1
	Fetal heart rate	89.5
	Laboratory examination	82.9
Counseling Intervention	Counseling/health education	57.1
	Mean±SD	87.6±10.7
	Tetanus toxoid immunization	87.6
	Iron/multivitamin supplementation	91.4
	Risk detection	92.4
	Referral (date recorded)	94.3
	Referral destination	94.3
	Pre-referral management	65.7

Identity recording was generally well implemented, although husband's age (87.6%) and maternal education (86.7%) were less consistently documented (**Table 2**). In the anamnesis component, several essential items were incompletely recorded, particularly MUAC (79.0%), CED classification (57.1%), maternal height (74.3%), history of illness (61.0%), allergy history (60.0%), and mode of previous delivery (63.8%). In the examination component, weight measurement (97.1%), gestational age assessment (97.1%), and fundal height measurement (98.1%) were commonly performed, whereas blood pressure measurement (78.1%) and laboratory examination (82.9%) were less consistently conducted. Counseling had the lowest implementation, with only 57.1% of women receiving health education. Preventive interventions, including tetanus toxoid immunization (87.6%) and iron supplementation (91.4%), were generally well implemented (**Table 2**).

Overall, key gaps were observed in counseling and nutritional assessment. Counseling coverage was limited, with only 57.1% of women receiving health education. Nutritional assessment was also incomplete, as reflected by suboptimal measurement of MUAC (79.0%), maternal height (74.3%), and classification of chronic energy deficiency (57.1%) (**Table 2**).

Development of composite performance indicators integrating quality and coverage

The performance on ANC service of village midwives was evaluated using both conventional coverage indicators and quality-adjusted composite indicators. Conventional indicators showed high mean coverage for K1 and K4, at 99.61% and 91.51%, respectively, indicating substantial utilization of ANC services (**Table 3**). However, when these coverage measures were adjusted by the level of 10T Standard implementation, the corresponding mean values declined to 84.89% for K1_{mod} and 77.94% for K4_{mod} (**Table 3**). This reduction indicates that performance based solely on service coverage may overestimate the actual quality of care delivered.

A significant difference was observed between the conventional and modified indicators. The mean values of K1_{mod} and K4_{mod} were significantly lower than those of K1 and K4 ($Z=8.84$ and $Z=7.04$, respectively; $p<0.001$) (**Table 3**). This indicated that coverage-based indicators overestimate midwife performance compared to quality-adjusted measures.

In addition to K1 and K4, other performance indicators showed that 69.5% deliveries met the standard for skilled birth attendance, whereas high-risk pregnancy detection was performed in only 27.6% of cases (**Table 3**). These findings suggested that although ANC utilization was generally high, important deficiencies remained in the quality and comprehensiveness of care. Overall, the composite indicators provided a more comprehensive assessment of performance by integrating service coverage with adherence to ANC quality standards using 10T framework.

Table 3. Performance of village midwives based on conventional indicators and new quality-adjusted composite indicators in Banda Aceh, Indonesia

Indicator	Frequency (%)	Z (p-value) ^a
Conventional indicators, mean (min-max)		
K1 coverage	99.61 (79.07 to 125.00)	
K4 coverage	91.51 (61.44 to 118.80)	
New quality-adjusted composite indicators, mean (min-max)		
Modified K1 (K1 _{mod})	84.89 (36.32 to 121.62)	8.84 (<0.001)
Modified K4 (K4 _{mod})	77.94 (35.57 to 115.54)	7.04 (<0.001)
Skilled birth attendance		
≥90% (meets standard)	73 (69.5)	
<90%	32 (30.5)	
High-risk pregnancy detection		
Performed	29 (27.6)	
Not performed	76 (72.4)	

^a Analyzed with Z-test of midwife performance using conventional indicators (K1 and K4)

Levels of individual, organizational, and psychological factors related to midwife performance on antenatal care services

Individual factors

The distribution of item-level responses for individual factors is presented in **Table 4**. Midwives generally demonstrated a good level of knowledge regarding ANC. Most respondents correctly understood key aspects of ANC, including pregnancy monitoring, risk detection, and preparation for safe delivery. However, gaps were observed in specific areas, particularly in updated service standards and the broader scope of ANC, such as preparation for the postpartum period and child development (**Table 4**).

Table 4. Distribution of item-level responses for individual factors related to midwife performance on antenatal care (ANC) among village midwives in Banda Aceh, Indonesia

Indicator	Item	Statement	Frequency (%)
Knowledge	1	ANC is only provided by midwives	85 (81.0)
	2	ANC monitors pregnancy progress	105 (100.0)
	3	ANC detects pregnancy risks and complications	105 (100.0)
	4	ANC prepares for safe delivery	105 (100.0)
	5	ANC prepares for the postpartum period	26 (24.8)
	6	ANC prepares mothers for exclusive breastfeeding	99 (94.3)
	7	ANC prepares child growth and development	39 (37.1)
	8	The latest ANC standard includes “7T”	30 (28.6)
	9	ANC visits should consider visit intervals (trimester-based)	86 (81.9)
	10	K4 refers to the fourth contact with health personnel	14 (13.3)
	11	Bleeding, persistent headache, visual disturbance, and decreased fetal movement are danger signs	105 (100.0)

Organizational and psychological factors

The score distribution of organizational and psychological factors is presented in **Table 5**. Overall, most indicators showed moderate to high mean scores. Higher scores were observed for work design (mean=3.73) and work structure (mean=3.66), reflecting relatively well-defined roles and coordination, whereas lower scores were found for resources (mean=2.50) and incentives (mean=3.39) (**Table 5**). Among psychological indicators, attitude had the highest mean score (4.34), while motivation (mean=3.68) and perception (mean=3.71) were comparatively lower (**Table 5**).

Table 5. Construct-level scores of organizational and psychological indicators related to midwife performance on antenatal care (ANC) among village midwives in Banda Aceh, Indonesia

Factor/construct	Indicator	Score mean±SD	Score (min-max)
Organizational	Resources	2.50±0.51	1.00–3.50
	Leadership	3.52±0.42	2.00–4.50
	Incentives	3.39±0.61	2.20–4.80
	Work structure	3.66±0.52	2.40–5.00
	Work design	3.73±0.45	2.67–4.75

Factor/construct	Indicator	Score mean±SD	Score (min-max)
Psychological	Perception	3.71±0.48	2.71–5.00
	Attitude	4.34±0.59	2.40–5.00
	Personality	3.89±0.62	2.25–5.00
	Learning	3.74±0.57	2.67–5.00
	Motivation	3.68±0.49	1.79–4.71

Structural equation modeling (SEM) analysis of factors associated with midwife performance

In our SEM analysis, individual, organizational, and psychological factors were modeled as exogenous latent constructs, 10T-based ANC quality as an intervening latent construct, and midwife performance as the final outcome construct. The individual construct was measured using knowledge, background, and demographic characteristics; the organizational construct by resources, leadership, incentives, work structure, and work design; and the psychological construct by perception, attitude, personality, learning, and motivation. The 10T-based ANC quality construct was indicated by medical, counseling, and intervention components. Midwife performance was indicated by K1 coverage, K4 coverage, skilled birth attendance, and high-risk pregnancy detection. The hypothesized structural pathways specified direct effects of individual, organizational, and psychological factors on both midwife performance and 10T-based ANC quality, as well as a direct effect of 10T-based ANC quality on midwife performance.

Measurement model evaluation

CFA was conducted to validate the measurement model. Standardized factor loadings for all indicators are presented in **Table 6**. Some indicators did not meet the recommended threshold of ≥ 0.50 , indicating insufficient contribution to their respective latent constructs. Within the organizational construct, work structure (0.35) and work design (0.42) had low loadings and were excluded from further analysis. Similarly, in the psychological construct, attitude (0.42) and motivation (0.38) did not meet the required threshold and were removed. All indicators for individual factors, 10T-based ANC, and performance demonstrated acceptable loadings and were retained. After excluding poorly performing indicators, the revised measurement model consisted only of indicators with satisfactory loadings, supporting the adequacy of the measurement model.

Table 6. Standardized factor loadings from confirmatory factor analysis (CFA) measurement model

Factors/construct	Indicator	Factor loading	Code used for SEM
Individual	Knowledge	0.75	X1#1
	Backgrounds	0.77	X1#2
	Demographic	0.80	X1#3
Organizational	Resources	0.65	X2#1
	Leadership	0.72	X2#2
	Incentives	0.77	X2#3
	Work structure	0.35*	X2#4
	Work design	0.42*	X2#5
Psychological	Perception	0.78	X3#1
	Attitude	0.42*	X3#2
	Personality	0.82	X3#3
	Learning	0.77	X3#4
	Motivation	0.38*	X3#5
10T-based antenatal care	Medical	0.68	Z2#2
	Counseling	0.75	Z2#3
	Intervention	0.80	Z2#4
Performance	K1	0.78	Y1#1
	K4	0.68	Y1#2
	Skilled birth	0.58	Y1#3
	Risk detection	0.75	Y1#4

* Excluded from structural equation modeling (SEM) analysis

Structural model fit

Following refinement of the measurement model, the structural model was evaluated. The model demonstrated an acceptable fit based on multiple goodness-of-fit indices (**Table 7**). Most indices met the recommended thresholds, including RMSEA (0.038), GFI (0.971), AGFI (0.939), TLI

(0.964), and CFI (0.981). Although the Chi-squared test was significant ($p=0.003$), other fit indices indicated that the model was acceptable for further analysis.

Table 7. Goodness-of-fit indices of the structural equation model (SEM) of ANC quality and midwife performance

Goodness-of-fit index	Cut-off value	Model estimate	Model evaluation
χ^2 (Chi-squared, $df=65$)	Expected to be low	100.594	Good
Probability (p -value)	≥ 0.05	0.003	Marginal
Root mean square error of approximation (RMSEA)	≤ 0.08	0.038	Good
Goodness-of-fit index (GFI)	≥ 0.90	0.971	Good
Adjusted goodness-of-fit index (AGFI)	≥ 0.90	0.939	Good
Tucker–Lewis index (TLI)	≥ 0.90	0.964	Good
Comparative fit index (CFI)	≥ 0.90	0.981	Good

Structural relationships and effects

The estimated structural relationships are presented in **Table 8**. All hypothesized paths were positive and statistically significant ($p<0.05$). Organizational, individual, and psychological factors had significant direct effects on midwife performance. Organizational factors have the largest direct effect on midwife performance ($\beta=0.361$, $p<0.001$), followed by individual ($\beta=0.128$, $p=0.048$) and psychological factors ($\beta=0.055$, $p=0.021$) (**Table 8**). The 10T-based ANC quality also had a strong and significant direct effect on midwife performance ($\beta=0.388$, $p<0.001$), indicating that better implementation of ANC standards is associated with improved performance (**Table 8**). The present study also found that organizational ($\beta=0.310$, $p<0.001$), individual ($\beta=0.124$, $p=0.039$), and psychological factors ($\beta=0.073$, $p=0.024$) had a significant and direct effect on ANC quality (**Table 8**).

Table 8. Estimated direct effects among individual, organizational, and psychological factors, antenatal care (ANC) quality, and midwife performance based on structural equation model (SEM)

Relationship between constructs	Estimate	p -value	Interpretation
Individual → Midwife performance	0.128	0.048	Significant
Organizational → Midwife performance	0.361	<0.001	Highly significant
Psychological → Midwife performance	0.055	0.021	Significant
10T-based ANC → Midwife performance	0.388	<0.001	Highly significant
Individual → 10T-based ANC	0.124	0.039	Significant
Organizational → 10T-based ANC	0.310	<0.001	Highly significant
Psychological → 10T-based ANC	0.073	0.024	Significant

The final structural model of SEM is presented in **Figure 1**. All hypothesized paths were positive and statistically significant ($p<0.05$). Organizational, individual, and psychological factors had significant direct effects on midwife performance, with organizational factors showing the largest standardized coefficient, followed by individual and psychological factors (**Figure 1**). These factors were also significantly associated with 10T-based ANC quality, again with organizational factors showing the strongest effect. In addition, 10T-based ANC quality had a significant positive effect on midwife performance (**Figure 1**).

The 10T-based ANC quality also functioned as a mediating variable in the relationship between the exogenous variables and midwife performance (**Figure 1**). Indirect effects through 10T-based ANC quality were identified for all exogenous variables, with the strongest indirect effect observed for organizational factors (**Figure 1**). This indicates that midwife performance was influenced both directly by individual, organizational, and psychological factors and indirectly through their effects on 10T-based ANC quality. The strongest pathway was observed for organizational factors, suggesting that better resources, leadership, and incentives were associated with higher ANC quality and improved midwife performance.

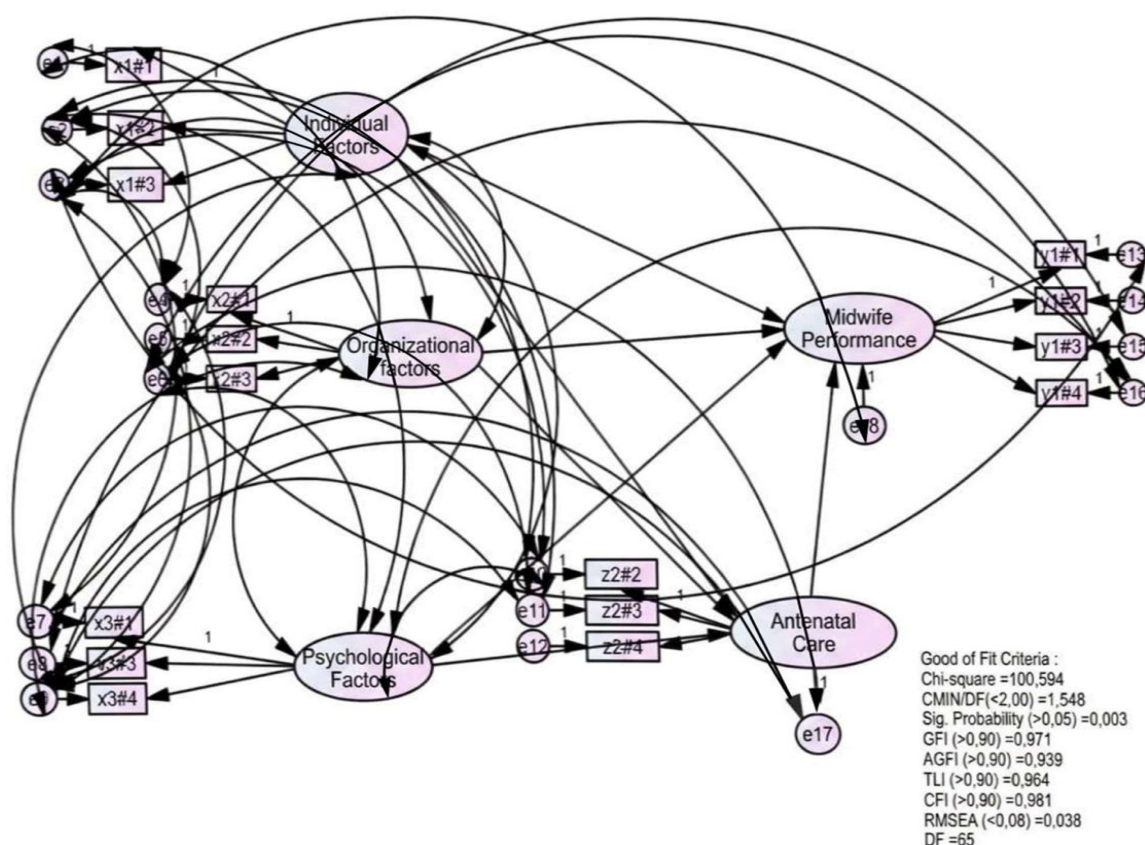


Figure 1. Final structural equation model showing the relationships among individual, organizational, and psychological factors, 10T-based ANC quality, and midwife performance in Banda Aceh, Indonesia. Code description: individual factors included knowledge (X1#1), background characteristics (X1#2), and demographic characteristics (X1#3); organizational factors included resources (X2#1), leadership (X2#2), incentives (X2#3), work structure (X2#4), and work design (X2#5); psychological factors included perception (X3#1), attitude (X3#2), personality (X3#3), learning (X3#4), and motivation (X3#5); 10T-based ANC quality included medical (Z2#2), counseling (Z2#3), and intervention (Z2#4) components; and midwife performance included K1 coverage (Y1#1), K4 coverage (Y1#2), skilled birth attendance (Y1#3), and high-risk pregnancy detection (Y1#4).

Decomposition of direct and indirect effects

The decomposition of total, direct, and indirect effects on midwife performance is presented in **Table 9**. Organizational factors had the largest total effect on midwife performance (0.782), consisting of both direct (0.361) and indirect effects (0.421). Individual factors had a smaller total effect (0.276), while psychological factors had the lowest total effect (0.123). The 10T-based ANC quality had a direct effect of 0.388 and no indirect effect.

Table 9. Decomposition of total, direct, and indirect effects of exogenous and intervening variables on midwife performance based on the structural equation model (SEM)

Variable	Total effect	Direct effect	Interpretation	Indirect effect	Interpretation
Individual	0.276	0.128	Relatively weak	0.148	Relatively weak
Organizational	0.782	0.361	Strong	0.421	Strong
Psychological	0.123	0.055	Weak	0.068	Weak
10T-based ANC	0.388	0.388	Strong; also strengthens indirect effects of other variables	0	No indirect effect

ANC: antenatal care

Discussion

This study evaluated midwife-delivered ANC performance in primary health services by integrating coverage and quality dimensions and examining factors associated with midwife performance. The findings showed that conventional ANC coverage indicators were high, but quality-adjusted performance indicators were substantially lower, indicating that coverage alone may overestimate actual service performance. Implementation of the 10T Standard varied across components, with lower performance observed in counseling, nutritional assessment, and initial management. The SEM analysis showed that organizational, individual, and psychological factors were associated with midwife performance, while 10T-based ANC quality functioned as an important pathway linking these factors to performance. The present SEM analysis also confirms that individual, organizational, and psychological factors had significant direct effects on 10T-based ANC quality, with organizational factors showing the strongest effect.

The implementation of the 10T Standard in ANC was not uniform across components, with relatively weaker performance observed in counseling and comprehensive assessment elements, particularly nutritional evaluation and risk identification. These findings indicate that while routine clinical procedures are well established, more comprehensive and preventive components of care remain suboptimal. Similar gaps have been reported in other settings, where essential components of ANC are not fully implemented despite high service utilization [13,14]. This pattern may reflect underlying constraints such as high workload, limited time for patient interaction, and a greater emphasis on routine, procedure-based tasks, which can reduce attention to counseling and comprehensive risk assessment.

The development and application of composite performance indicators integrating both coverage and quality revealed important discrepancies in performance measurement. Although conventional indicators such as K1 and K4 showed high coverage, the corresponding quality-adjusted indicators ($K1_{mod}$ and $K4_{mod}$) were significantly lower, suggesting that conventional coverage measures may overestimate actual performance when quality dimensions are not considered. It also demonstrates that high service utilization does not necessarily reflect the completeness or effectiveness of care. Previous evidence similarly indicates that access to care alone is insufficient to ensure quality, as service delivery is influenced by contextual factors, including sociodemographic characteristics influencing utilization [15], as well as the technical quality of care [16]. This interpretation aligns with established frameworks emphasizing that healthcare quality is primarily determined by care processes rather than utilization alone [17-20].

The analysis of determinants indicates that midwife performance is influenced by a combination of individual, organizational, and psychological factors. Organizational components such as resources, leadership, and incentives were identified as important contributors to performance, whereas work structure and work design were less influential. These findings are consistent with broader evidence on determinants of midwifery performance in ANC settings [21]. Previous studies have similarly shown that supervision, training, and incentives are key determinants of health worker performance [22,23], and that supportive organizational conditions enhance motivation and service quality [24,25]. In addition, practical interventions such as mentorship programs have demonstrated improvements in maternal and neonatal outcomes by strengthening workforce capacity and clinical practice [26].

The strong influence of organizational factors observed in this study has important implications for health policy in Indonesia. Organizational support may be strengthened through the strategic use of Village Funds and the National Health Insurance (JKN) program to improve the availability of essential resources, infrastructure, and supervision for village midwives. These findings suggest that policy interventions targeting health system capacity may be as important as individual-level training in improving the quality of antenatal care.

Although individual factors such as knowledge and experience were generally adequate among respondents, gaps remained in specific areas, suggesting that individual capacity alone may not be sufficient to ensure optimal performance. The low quality observed in some ANC components, particularly counseling, should not necessarily be attributed to limited motivation or skills among midwives. Instead, it may reflect systemic barriers that constrain midwives in carrying out their duties, including limited time, inadequate supervision, insufficient counseling materials, and lack of essential infrastructure at the village level. Therefore, strengthening 10T

implementation should include not only improvement of counseling skills but also better availability of resources, tools, and organizational support. In the final model, fewer psychological indicators met the factor loading criteria, indicating that this construct had a more limited contribution in explaining performance variation. These findings suggest that although individual and psychological factors remain relevant, their effects may be secondary to broader organizational conditions. This interpretation is consistent with evidence indicating that competencies require enabling environments to be translated into practice [27,28] and that organizational context plays a central role in shaping workforce outcomes [29,30]. Evidence from Indonesia also highlights variability in midwifery service provision, particularly in rural areas where service availability and workforce distribution influence performance [31].

The SEM analysis further clarifies the relationships among individual, organizational, and psychological factors. All three factors had significant effects on ANC quality, with organizational factors showing the largest contribution. The 10T-based ANC quality also had a strong and significant direct effect on midwife performance. Moreover, the stronger indirect effects compared to direct effects indicate that improvements in midwife performance primarily occur through enhanced ANC quality rather than through direct influences of individual, organizational, or psychological factors. This demonstrates that ANC quality functions as a key mediating variable linking upstream factors to midwife performance outcomes.

These SEM findings highlight that improvements in workforce capacity alone are insufficient without strengthening service delivery systems. Evidence from global health systems supports that service delivery quality mediates the relationship between system inputs and health outcomes [32], and that improving performance requires integrated approaches that align workforce capacity, organizational support, and care standards [33–35]. Strengthening the maternal health workforce through coordinated institutional strategies and learning systems has also been identified as an important approach to improving service quality and equity [36]. In addition, effective service delivery depends on staff agency, teamwork, and strong management support [37].

The gaps identified in counseling, nutritional assessment, and risk detection further emphasize the importance of strengthening care processes. Although risk detection procedures were reported in most cases, only a small proportion of high-risk pregnancies were identified, indicating a gap between service provision and clinical interpretation. Similar patterns have been reported in other settings, where structural constraints such as limited resources, inadequate training, and insufficient supervision reduce the effectiveness of ANC services [14,38-40].

Overall, the findings indicate a clear pathway in which organizational factors influence ANC quality, which in turn determines midwife performance, while individual and psychological factors play supporting roles. From a practical perspective, strengthening organizational capacity—particularly leadership, resource availability, and incentive systems—is essential to ensure consistent implementation of ANC standards and to improve overall performance outcomes. This can be achieved by enhancing supportive supervision and feedback mechanisms, ensuring adequate availability of essential equipment and supplies, and implementing performance-based incentives aligned with service quality. Evidence suggests that participatory approaches, combined with training, supervision, and provision of essential resources, can improve the quality of ANC delivery even in resource-constrained settings [41]. In addition, strengthening in-service training and continuous professional development, particularly in counseling and comprehensive risk assessment, is critical, as gaps in provider capacity, content delivery, and integration of maternal nutrition counseling remain common [42]. Broader health system strengthening efforts, including improvements in supply chain management, training, and supervisory practices, are also necessary to support effective implementation of ANC interventions [43]. Efforts to improve teamwork, communication, and coordination at the primary care level are also important to support effective service delivery.

From a policy perspective, several actions are recommended. Primary health centers should strengthen supportive supervision focused on completion of 10T components, particularly counseling, MUAC measurement, CED classification, and risk interpretation. District and city health offices should ensure the availability of essential ANC equipment and counseling materials, standardize 10T monitoring tools, and provide regular feedback to midwives based on quality-

adjusted indicators rather than coverage alone. Training should prioritize therapeutic communication, nutritional assessment, risk detection, and referral decision-making. In addition, performance monitoring systems should consider incorporating $K1_{mod}$ and $K4_{mod}$ as complementary indicators to identify gaps between ANC contact coverage and service quality.

This study has several limitations that need to be acknowledged. The cross-sectional design limits causal interpretation and does not capture changes in performance over time. The study was also conducted in a single urban setting, which may limit the generalizability of the findings to other contexts with different resource availability, workforce distribution, and health system conditions. In addition, although the sample size met the minimum requirement used for SEM estimation in this study, it was relatively small for complex SEM analysis. Therefore, the stability and generalizability of the model estimates should be interpreted cautiously. The use of secondary data from maternal health records may introduce inaccuracies due to incomplete or inconsistent documentation, as well as potential differences between recorded and actual practices. The measurement of ANC quality was based on checklist indicators, which may not fully capture important qualitative aspects of care, such as counseling effectiveness, communication quality, or client experience. During model refinement, several indicators were excluded due to low factor loadings, potentially reducing the comprehensiveness of the latent constructs. Although cluster sampling was used, clustering effects were not formally adjusted in the SEM analysis because of the limited number of clusters and the modest sample size. This may have led to underestimation of standard errors if responses were correlated within primary health centers. Finally, contextual constraints such as high workload, limited time, inadequate infrastructure, and insufficient support systems may have influenced service delivery but were not fully captured in the model. Future longitudinal studies with larger samples across multiple districts, more comprehensive measurement models, and cluster-adjusted or multilevel analytical approaches are needed to validate the proposed model and quality-adjusted indicators.

Conclusion

High ANC coverage (based on $K1$ and $K4$) may overestimate midwife performance by failing to capture gaps in service quality, particularly in counseling, nutritional assessment, and risk detection. The use of a composite indicator incorporating the 10T Standard provides a more comprehensive assessment by integrating both the extent and quality of care. Midwife performance was influenced by a combination of individual, organizational, and psychological factors, with organizational factors emerging as the most influential determinants. These factors affected performance both directly and indirectly through their impact on ANC quality. The structural model further demonstrates that 10T-based ANC quality functions as a key mediating pathway through which upstream factors are translated into measurable performance outcomes, indicating that improvements in performance are primarily achieved through strengthening service delivery processes rather than increasing service coverage alone. Overall, these findings highlight the importance of shifting from coverage-based evaluation toward quality-oriented approaches, with particular emphasis on strengthening organizational capacity and ensuring the consistent implementation of ANC standards to improve maternal health services.

Ethics approval

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Syiah Kuala University/Dr. Zainoel Abidin Regional General Hospital under approval number 13/EA/FK/2018. All participants were informed about the objectives of the study and provided written informed consent prior to participation.

Acknowledgments

None.

Competing interests

All the authors declare that there are no conflicts of interest.

Funding

This study received no external funding.

Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

The artificial intelligence-based language model ChatGPT was employed to refine the language (improving grammar, sentence structure, and readability of the manuscript). We confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were solely made by the authors.

How to cite

Ibrahim T, Syukri M, Sofyan H, Nurjannah N. Quality-adjusted assessment and determinants of midwife-delivered antenatal care performance in primary health services: Evidence from Indonesia. *Narra X* 2026; 4 (2): e285 - <http://doi.org/10.52225/narrax.v4i2.285>.

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