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Research article

Determinants of Knowledge Gaps among Rural Women on Pregnancy Risk Ages and Birth Intervals: Evidence from a Community Survey in Bangladesh

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ABSTRACT

Pregnancy before age 18, pregnancy after age 35, and minimum intervals between a live birth and the next pregnancy are associated with adverse maternal and newborn outcomes. However, evidence on whether rural women know these specific risk thresholds - remains limited in Bangladesh. This study assessed three knowledge outcomes and examined their socioeconomic, household, and service-related correlates. A community-based cross-sectional survey was conducted among 160 women aged 15-49 years from four rural unions in Gazipur, Rajshahi, and Kishoreganj districts. Correct knowledge was defined as identifying pregnancy before age 18 as risky, pregnancy after age 35 as risky, and a minimum interval of 24 months from a live birth to the next pregnancy. Bivariate associations were examined using Pearson chi-square tests. Separate binary logistic regression models were estimated for each outcome, with 1,000 simple bootstrap resamples used as a sensitivity check. Correct knowledge was low: 18.8% identified the early-age threshold, 16.3% identified the advanced-age threshold, and 12.5% identified the recommended birth-to-next-pregnancy interval. In adjusted analysis, availability of public health facilities was associated with higher odds of correct early-age knowledge than availability of informal providers (AOR=5.72, 95% CI 1.21-27.14; p=.028). For advanced-age knowledge, public facilities (AOR=9.87, 95% CI 1.17-83.20; p=.035) and public-private-NGO services (AOR=11.60, 95% CI 1.20-112.35; p=.034) were associated with higher odds than informal-provider settings. The findings suggest substantial, setting-specific knowledge gaps in the four sampled unions. Routine maternal-health counselling should state age-related risks and the recommended birth-to-pregnancy interval clearly, while also engaging household decision-makers and informal providers.

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Introduction

Bangladesh has made significant progress in maternal healthcare, however preventable reproductive risks still remain a concern in public healthcare service system (National Institute of Population Research and Training [NIPORT] & ICF, 2023). Pregnancies that occur very early or in late, or soon after the previous birth are associated with severe adverse outcomes for women as well as for newborns (Ahrens et al., 2019; Schummers et al., 2018; World Health Organization, 2020; Conde-Agudelo et al., 2012; Ganchimeg et al., 2014; Lean et al., 2017). These are clinically established risks. However, knowledge of the relevant age and spacing thresholds among community women in reproductive age is very poor and less well documented (Uddin et al., 2024; Begum et al., 2023).

The World Health Organization recommends waiting at least 24 months after a live birth before attempting the next pregnancy. This corresponds to an interval of roughly 33 months between births (World Health Organization [WHO], 2007). In Bangladesh, early childbearing and short birth intervals remain visible in national survey data, despite expanded family-planning, antenatal-care, and postnatal-care services (NIPORT & ICF, 2020; NIPORT

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et al., 2023). Those national analyses describe and present when births occur, who experiences short intervals, or which services women use. They rarely measure whether women know the exact age thresholds or the recommended birth-to-next-pregnancy interval. Knowledge and behavior must be separated analytically. Knowing a risk does not ensure that a woman can delay pregnancy, use contraception, or obtain care. Fertility decisions may still be constrained by household authority, gender preference, cost, access, and social expectations. Knowledge is therefore treated here as a cognitive outcome in its own right. It may support risk recognition and informed discussion, but this cross-sectional study does not test whether knowledge changes behavior.

Several studies conducted in Bangladesh have examined reproductive-health practices, adolescent childbearing, service use, and birth spacing. Besides, a number of research published in Khulna University Studies has also documented broad reproductive-health knowledge among adolescent girls and married women (Chanda & Jabbar, 2010; Chandra et al., 2020; Hossain et al., 2017). Those studies are important, but they do not directly estimate adult rural women's knowledge of pregnancy before age 18, pregnancy after age 35, and a 24-month birth-to-next-pregnancy interval as three separate outcomes. This distinction defines the present research gap. The study had three objectives: (1) To estimate the proportion of women who correctly knew each threshold, (2) To examine individual, household, and service-related correlates of correct knowledge, and (3) To identify implications for maternal-health communication in the sampled rural settings. The analysis focuses on association rather than causation.

Literature Review and Conceptual Framework

Maternal-age and birth-spacing risks

Adolescent pregnancy is associated with increased risks of eclampsia, puerperal infection, preterm birth, and poor neonatal outcomes, although the size of risk varies by structural determinants such as socioeconomic status, geographic access, and quality of prenatal care (Abate et al., 2024; Ganchimeg et al., 2014). Similarly, advanced maternal age is also associated with higher risks of stillbirth, preterm birth, hypertensive disorders, and other complications (Thayyil et al., 2025; Lean et al., 2017). These clinical findings explain why age-specific knowledge is relevant. They do not, however, show whether women know the thresholds or can act on that information. On the other hand, short intervals between two births are associated with preterm birth, low birth weight, maternal depletion, and infant mortality (Beyene et al., 2025; Shi et al., 2023; Pimentel et al., 2020; Conde-Agudelo et al., 2012). A global meta-analysis involving over 46 million pregnancies demonstrated a dose–response relationship where interpregnancy intervals under 6 months significantly elevate the risk of preterm delivery, low birth weight, and neonatal death (Shi et al., 2023). Evidence from Bangladesh continues to confirm these risks locally, showing that newborns born following short birth intervals experience significantly higher rates of neonatal and under-five mortality compared to those born after recommended spacing (Islam et al., 2023; de Jonge et al., 2014). Many studies treat interval length as an outcome and examine education, wealth, contraceptive use, child loss, or service readiness as predictors. Knowledge is often included as a background characteristic or omitted altogether. This limits understanding of the information gap that precedes reproductive decisions.

Reproductive-health knowledge in Bangladesh

National surveys provide strong evidence on fertility, age at first birth, contraceptive use, antenatal care, and postnatal care (NIPORT & ICF, 2023). These measures show what women experience and which services they use. They are less suited to assessing precise knowledge of early-age risk, advanced-age risk, and the minimum birth-to-pregnancy interval. A woman may know about contraception or the legal age at marriage but still be unable to state when pregnancy becomes medically risky.

Recent studies confirm that reproductive-health knowledge in Bangladesh remains highly uneven across demographics and geography. Recent assessments among adolescent boys and girls in Dhaka and surrounding districts reveal persistent gaps in knowledge surrounding sexual and reproductive health rights (SRHR), menstrual hygiene management, safe motherhood, and routine health service utilization (Khandaker et al., 2025; Zakaria et al., 2023). Research on married women continues to demonstrate that knowledge of reproductive risks and adoption of maternal services are heavily mediated by formal educational attainment, household socioeconomic status, and localized healthcare infrastructure (Al-Zubayer et al., 2023; Sultana et al., 2024). While these findings underscore the broader significance of health literacy, their target populations and outcome metrics differ from the three threshold-specific outcomes evaluated in this study.

Service access may matter because counselling provides opportunities to learn. Studies confirm that availability, accessibility, provider conduct, and service experience were central to users' assessments of care (Chowdhury et al., 2024; Mamun et al., 2023). Direct contact with a health facility does not guarantee effective communication, but the service environment may shape exposure to reliable maternal-health information. Furthermore, household dynamics such as including autonomy in decision-making, partner support, and gender preferences - continue to significantly shape both maternal healthcare utilization and birth timing in rural and urban Bangladesh (Mistry et al., 2024; Story & Burgard, 2012).

Adapted social-ecological framework

This research uses an adapted social-ecological framework (McLeroy et al., 1988). This framework is better aligned with the measured variables than a formal test of the Health Belief Model or the Theory of Planned Behavior. The survey did not directly measure perceived susceptibility, perceived severity, behavioral intention, or perceived behavioral control with validated scales. It would therefore be inappropriate to claim that those theories were tested.

The adapted framework places predictors at three levels. The individual level includes education and maternal-health knowledge. The household level includes the education of the household decision-maker and child-gender preference. The service and community level includes the availability and type of maternal-health

providers. The three dependent variables are knowledge outcomes. The knowledge-attitude-practice distinction is retained only to clarify that knowledge may precede attitude and practice but is not equivalent to either (Launiala, 2009).

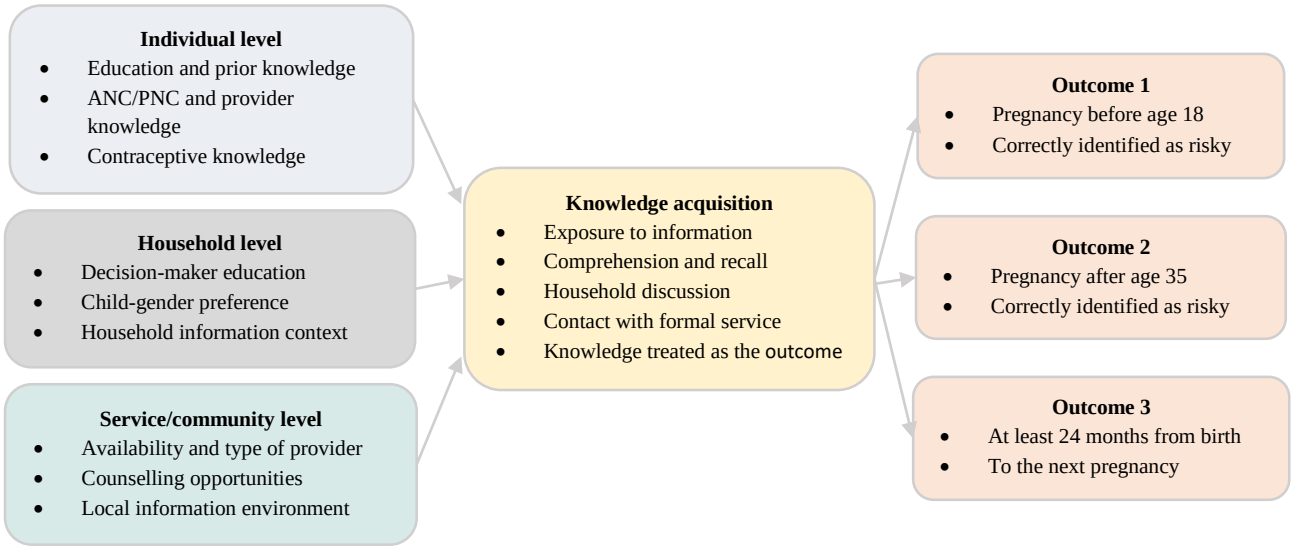

Figure 1: Adapted social-ecological framework for maternal-health knowledge outcomes

Note: The framework organizes measured correlates by level of influence.

Research gap and expectations

Existing evidence establishes the health relevance of age and spacing, but it offers limited information on rural women's exact threshold knowledge in Bangladesh. This study addresses that gap by analyzing three binary knowledge outcomes separately. Based on the framework, correct knowledge was expected to vary with prior maternal-health knowledge, household context, and the local service environment. These expectations were examined as associations, not causal hypotheses.

Materials and Methods

Study Area and Survey Design

A community-based cross-sectional survey was conducted among women aged 15-49 years who had experienced at least one pregnancy and were living in the selected rural communities. One eligible woman was interviewed per household. Women who were not permanent residents, did not meet the eligibility criteria, or declined informed consent were excluded.

Study setting and site selection

Three districts were purposively selected to represent contrasting maternal-mortality contexts using routine maternal-mortality data recorded in the Directorate General of Health Services' District Health Information Software 2 system. Gazipur represented the comparatively low-mortality setting, Rajshahi the intermediate setting, and Kishoreganj the comparatively high-mortality setting. Four rural unions were included: Pakuria Union in Bagha Upazila and Charghat Union in Charghat Upazila, Rajshahi; Rayed Union in Kapasia Upazila, Gazipur; and Patuabhanga Union in Pakundia Upazila, Kishoreganj. Their reported populations were 21,929, 22,169, 26,797, and 38,436, respectively. Rajshahi contributed two union-level clusters because it was the only divisional-headquarters district among the three sites.

Sample-size determination and sampling

A priori calculation specified in the study protocol produced a target of 160 women. The target was allocated equally across the four unions, with 40 respondents per union. The resulting district distribution was 80 respondents in Rajshahi and 40 each in Gazipur and Kishoreganj. This allocation supported comparison across four community clusters; it was not probability-proportional-to-size sampling and does not produce nationally representative estimates.

A multistage procedure was used. In Rajshahi, two upazilas were randomly selected, followed by one union from each selected upazila. Two villages were randomly selected from every study union. Each village was divided into four geographic blocks containing approximately 100-125 households. After a random starting point was identified, every tenth household was approached until the union quota was met. If a selected household was ineligible, unavailable after the planned contact attempts, or declined participation, the next eligible household was approached according to the field replacement protocol.

Data collection

Data were collected in June and July 2024 using a structured Bengali questionnaire informed by the Bangladesh Demographic and Health Survey, WHO maternal-health guidance, and prior reproductive-health research. The instrument covered sociodemographic characteristics, maternal-health knowledge, service availability and use, birth planning, contraceptive knowledge, and household norms. It was pretested with 20 women in a non-study area. Trained female enumerators conducted face-to-face interviews in respondents' homes under field supervision. Interviews lasted approximately 10-15 minutes.

Outcome definitions

Outcome	Survey concept	Correct response	Coding
Early-age pregnancy-risk knowledge	Before which age is pregnancy risky?	Before age 18	1=correct; 0=wrong/don't know
Advanced-age pregnancy-risk knowledge	After which age is pregnancy risky?	After age 35	1=correct; 0=wrong/don't know
Recommended birth-to-pregnancy interval	Minimum time from the birth of one child to the next pregnancy	At least 24 months	1=correct; 0=wrong/don't know

Note: The spacing outcome refers to the interval from a live birth to the next pregnancy, not the interval between two births. The pregnancy-age outcomes are distinct from the legal age at marriage.

Predictor variables

Predictors were selected from the adapted framework and from variables available for all 160 respondents. They included household decision-maker education, knowledge of an appropriate provider for pregnancy danger signs, local maternal-health service availability, knowledge of common ANC/PNC checkups, knowledge of postpartum observation, contraceptive knowledge, and child-gender preference. Treatment location, perceived service quality, and treatment outcome were described only among the 97 women who had sought care and were not used to reduce the primary analytic sample.

Statistical analysis

Data were analysed in IBM SPSS Statistics version 27. Frequencies and percentages summarized participant characteristics and knowledge outcomes. Pearson chi-square tests assessed bivariate associations. Two-sided Fisher exact tests were reported for 2x2 tables with sparse expected counts. A p-value below .05 was treated as statistically significant; values from .05 to below .10 were described as suggestive and were not presented as significant.

Separate binary logistic regression models were estimated for the three outcomes. A common set of seven predictors was entered to maintain comparability across models, categorical predictors generated nine parameters. Adjusted odds ratios (AORs), 95% Wald confidence intervals, and two-sided p-values were reported for every entered category. Model summaries included the likelihood-ratio chi-square, Nagelkerke R-squared, and the Hosmer-Lemeshow test. One thousand simple bootstrap resamples with 95% percentile intervals were used as a sensitivity check.

Correct responses were uncommon: 30 for early-age knowledge, 26 for advanced-age knowledge, and 20 for spacing knowledge. The standard maximum-likelihood models for Outcomes 1 and 3 reached the iteration limit because of complete or quasi-complete separation. Affected coefficients were marked not estimable and were not interpreted. The adjusted analyses are therefore exploratory.

Ethical considerations

The Institute of Bangladesh Studies Research Ethics Committee approved the study. Local government institutes and health authorities were informed. Respondents received verbal and written information, provided informed consent, and could withdraw at any time. No direct personal identifiers were collected or use in the analytic dataset.

Results

Respondent characteristics and service experience

The study included 160 women. Most had fewer than 12 years of education (71.9%), and 84.4% were not engaged in paid work. Household decision-makers had fewer than 12 years of education in 78.1% of households (Table 1). General maternal-health knowledge was uneven. For example, 67.5% correctly identified advantages or disadvantages of contraception, whereas only 6.3% correctly identified the recommended period of postpartum observation (Table 2).

Table 1: Sociodemographic characteristics of respondents (N=160)

Category	Variable	n	%
Study-site mortality category	Comparatively high (Kishoreganj)	40	25.0
	Intermediate (Rajshahi)	80	50.0
	Comparatively low (Gazipur)	40	25.0
Age group	15-35 years	85	53.1
	36-49 years	75	46.9
Respondent education	0-11 years	115	71.9
	12+ years	45	28.1
Decision-maker education	0-11 years	125	78.1
	12+ years	35	21.9
Occupation	Not earning	135	84.4
	Earning	25	15.6
Household economic status	Lower middle	79	49.4
	Upper middle	81	50.6

Source: Community survey, 2024.

Table 2: Selected maternal-health knowledge and household-context indicators (N=160)

Category	Variable	n	%
Pregnancy danger-sign knowledge	No/limited	123	76.9
	Moderate	37	23.1
Appropriate provider knowledge	No/limited	113	70.6
	Moderate	47	29.4
Birth-planning knowledge	Limited	80	50.0
	Moderate	80	50.0
ANC/PNC checkup knowledge	No knowledge	27	16.9
	Limited	107	66.9
	Moderate	26	16.3
PNC checkup required	Wrong/don't know	59	36.9
	Correct	101	63.1
PNC within 24 hours	Wrong/don't know	62	38.8
	Correct knowledge	98	61.3
Postpartum observation period	Wrong/don't know	150	93.8
	Correct knowledge	10	6.3
Contraceptive knowledge	Wrong/don't know	52	32.5
	Correct	108	67.5
Local provider availability	Public facilities	102	63.7
	Public-private-NGO	21	13.1
	Informal providers	37	23.1
Child-gender preference	Preference	43	26.9
	No preference	117	73.1

Source: Community survey, 2024.

Table 3: Service utilization and treatment experience (N=160)

Category	Variable	n	% of full sample	% among service users
Place sought care	Public health facilities	57	35.6	58.8
	Private/NGO facilities or providers	29	18.1	29.9
	Public, private, and informal sources	11	6.9	11.3
	Did not seek care	63	39.4	-
Perceived service quality	Poor (20-40% satisfaction)	24	15.0	24.7
	Good (60-80% satisfaction)	73	45.6	75.3
	Did not visit a provider	63	39.4	-
Reported treatment outcome	Temporary recovery; later deterioration	24	15.0	24.7
	Complete recovery	73	45.6	75.3
	Did not receive treatment	63	39.4	-

Source: Community survey, 2024.

Note: Full-sample percentages use N=160. Percentages among service users use n=97 and are not applicable to respondents who did not seek care.

Ninety-seven women (60.6%) reported seeking care for pregnancy danger signs. Among these service users, 58.8% attended public facilities, 29.9% used private or NGO providers, and 11.3% used more than one type of provider. Three-quarters rated the service as good and reported complete recovery. These figures describe service users only; the knowledge analyses used in this research paper were all 160 respondents.

Knowledge outcomes and bivariate associations

Thirty women (18.8%) women correctly identified pregnancy before age 18 as risky, 26 (16.3%) identified pregnancy after age 35 as risky, and 20 (12.5%) identified the recommended 24-month birth-to-next-pregnancy interval.

Table 4: Bivariate associations with correct knowledge of pregnancy risk before age 18 (N=160)

Category	Variable	Correct n (%)	Wrong/unknown n (%)	Chi-square	p
Decision-maker education	0-11 years	26 (20.8)	99 (79.2)	1.576	.209
	12+ years	4 (11.4)	31 (88.6)		
Provider knowledge	No/limited	18 (15.9)	95 (84.1)	2.009	.156
	Moderate	12 (25.5)	35 (74.5)		
Service availability	Public facilities	27 (26.5)	75 (73.5)	11.013	.004
	Public-private-NGO	1 (4.8)	20 (95.2)		
	Informal providers	2 (5.4)	35 (94.6)		
PNC checkup knowledge	Wrong/don't know	14 (23.7)	45 (76.3)	1.521	.217
	Correct	16 (15.8)	85 (84.2)		
PNC within 24 hours	Wrong/don't know	15 (24.2)	47 (75.8)	1.969	.161
	Correct knowledge	15 (15.3)	83 (84.7)		
Child-gender preference	Preference	12 (27.9)	31 (72.1)	3.237	.072
	No preference	18 (15.4)	99 (84.6)		

Source: Community survey, 2024.

Service availability was associated with early-age risk knowledge (chi-square (2) =11.013, p=.004). Correct knowledge was reported by 26.5% of women who identified public facilities as locally available, compared with 4.8% in public-private-NGO settings and 5.4% in informal-provider settings. Child-gender preference showed a suggestive association (p=.072), but it was not statistically significant 5% level of significance.

Table 5: Bivariate associations with correct knowledge of pregnancy risk after age 35 (N=160)

Category	Variable	Correct n (%)	Wrong/unknown n (%)	Chi-square	p
Decision-maker education	0-11 years	16 (12.8)	109 (87.2)	4.998	.025
	12+ years	10 (28.6)	25 (71.4)		
Provider knowledge	No/limited	19 (16.8)	94 (83.2)	0.090	.764
	Moderate	7 (14.9)	40 (85.1)		
Service availability	Public facilities	19 (18.6)	83 (81.4)	7.756	.021
	Public-private-NGO	6 (28.6)	15 (71.4)		
	Informal providers	1 (2.7)	36 (97.3)		
PNC checkup knowledge	Wrong/don't know	7 (11.9)	52 (88.1)	1.321	.250
	Correct	19 (18.8)	82 (81.2)		
PNC within 24 hours	Wrong/don't know	8 (12.9)	54 (87.1)	0.833	.361
	Correct knowledge	18 (18.4)	80 (81.6)		
Child-gender preference	Preference	4 (9.3)	39 (90.7)	2.086	.149
	No preference	22 (18.8)	95 (81.2)		

Source: Community survey, 2024.

Decision-maker education (chi-square (1) =4.998, p=.025) and service availability (chi-square (2) =7.756, p=.021) were significantly associated with advanced-age risk knowledge. Correct knowledge was reported by 28.6% of women in households with a decision-maker who had at least 12 years of education, compared with 12.8% in the lower-education group. Only one woman (2.7%) in informal-provider settings answered correctly.

Table 6: Bivariate associations with correct knowledge of the recommended birth-to-pregnancy interval (N=160)

Category	Variable	Correct n (%)	Wrong/unknown n (%)	Test statistic	p
Decision-maker education	0-11 years	13 (10.4)	112 (89.6)	Fisher exact	.150
	12+ years	7 (20.0)	28 (80.0)		
Provider knowledge	No/limited	9 (8.0)	104 (92.0)	7.235	.007
	Moderate	11 (23.4)	36 (76.6)		
Service availability	Public facilities	14 (13.7)	88 (86.3)	2.666	.264
	Public-private-NGO	4 (19.0)	17 (81.0)		
	Informal providers	2 (5.4)	35 (94.6)		
PNC checkup knowledge	Wrong/don't know	3 (5.1)	56 (94.9)	4.699	.030
	Correct	17 (16.8)	84 (83.2)		
PNC within 24 hours	Wrong/don't know	5 (8.1)	57 (91.9)	1.821	.177
	Correct knowledge	15 (15.3)	83 (84.7)		
Child-gender preference	Preference	2 (4.7)	41 (95.3)	3.312	.069
	No preference	18 (15.4)	99 (84.6)		

Source: Community survey, 2024.

Provider knowledge (chi-square (1) =7.235, p=.007) and knowledge that a PNC checkup is required (chi-square (1) =4.699, p=.030) were significantly associated with correct birth spacing knowledge. Child-gender preference showed a suggestive association (p=.069).

Table 7: Comparative summary of selected bivariate associations (N=160)

Category	Variable	Early-age correct n (%)	p	Advanced-age correct n (%)	p	Spacing correct n (%)	p
Decision-maker education	0-11 years	26 (20.8)	.209	16 (12.8)	.025	13 (10.4)	.150*
	12+ years	4 (11.4)		10 (28.6)		7 (20.0)	
Provider knowledge	No/limited	18 (15.9)	.156	19 (16.8)	.764	9 (8.0)	.007
	Moderate	12 (25.5)		7 (14.9)		11 (23.4)	
Service availability	Public facilities	27 (26.5)	.004	19 (18.6)	.021	14 (13.7)	.264
	Public-private-NGO	1 (4.8)		6 (28.6)		4 (19.0)	
	Informal providers	2 (5.4)		1 (2.7)		2 (5.4)	
PNC checkup knowledge	Wrong/don't know	14 (23.7)	.217	7 (11.9)	.250	3 (5.1)	.030
	Correct	16 (15.8)		19 (18.8)		17 (16.8)	
PNC within 24 hours	Wrong/don't know	15 (24.2)	.161	8 (12.9)	.361	5 (8.1)	.177
	Correct knowledge	15 (15.3)		18 (18.4)		15 (15.3)	
Child-gender preference	Preference	12 (27.9)	.072	4 (9.3)	.149	2 (4.7)	.069
	No preference	18 (15.4)		22 (18.8)		18 (15.4)	

Source: Community survey, 2024.

Note: *Two-sided Fisher exact p-value. Values from .05 to below .10 are suggestive, not statistically significant.

Multivariable associations

All three omnibus models were statistically significant, but the low number of correct responses limited precision. Public-facility availability was associated with higher adjusted odds of early-age knowledge than informal-provider availability. For advanced-age knowledge, both public and public-private-NGO settings had higher adjusted odds than informal-provider settings. The confidence intervals were wide. No stable individual predictor reached the .05 threshold in the spacing model. Estimates affected by separation were not interpreted.

For early-age knowledge, public-facility availability was associated with higher odds than informal-provider availability (AOR=5.72, 95% CI 1.21-27.14; p=.028) (Table 8). For advanced-age knowledge, the corresponding estimates were AOR=9.87 (95% CI 1.17-83.20; p=.035) for public facilities and AOR=11.60 (95% CI 1.20-112.35; p=.034) for public-private-NGO services. These large estimates had very wide intervals. The overall two-degree-of-freedom service-availability test in the advanced-age model was only suggestive (p=.089). No stable independent association was identified for birth spacing knowledge. Provider knowledge (p=.056) and child-gender preference (p=.064) were imprecise and non-significant patterns rather than confirmed effects.

Discussion

Principal findings

The study identified marked gaps in knowledge of pregnancy timing. Fewer than one in five women knew the early or advanced-age risk threshold, and one in eight knew the recommended birth-to-next-pregnancy interval. These proportions were substantially lower than knowledge of several general maternal-health topics. Broad awareness of contraception or postnatal care therefore did not imply knowledge of specific pregnancy-timing recommendations.

Table 8: Factors Associated with Knowledge of Pregnancy-Risk Ages and Spacing of Birth-to-next-Pregnancy

Factors	Outcome 1: Risk before age 18			Outcome 2: Risk after age 35			Outcome 3: Recommended birth-to-next-pregnancy interval		
	AOR	95% CI	p-value	AOR	95% CI	p-value	AOR	95% CI	p-value
Education of household decision-maker									
High (12+ years)			Ref.			Ref.			Ref.
Low (0–11 years)	1.73	0.52–5.84	0.374	0.51	0.19–1.37	0.180	0.52	0.17–1.63	0.262
Knowledge of appropriate healthcare provider									
Moderate			Ref.			Ref.			Ref.
No/limited	0.81	0.28–2.36	0.695	0.78	0.25–2.45	0.671	0.27	0.07–1.04	0.056
Maternal-health service availability									
Informal providers/centres			Ref.			Ref.			Ref.
Public health facilities	5.72	1.21–27.14	0.028	9.87	1.17–83.20	0.035	0.96	0.17–5.41	0.961
Public-private-NGO facilities/providers	1.12	0.09–14.67	0.929	11.60	1.20–112.35	0.034	1.08	0.15–7.88	0.942
Knowledge of ANC/PNC checkups									
Moderate			Ref.			Ref.			Ref.
No knowledge	0.72	0.15–3.54	0.690	1.93	0.20–18.77	0.572	NE	—	—
Limited	0.65	0.19–2.26	0.501	4.23	0.75–23.80	0.102	0.73	0.18–2.90	0.654
Postpartum observation knowledge									
Correct			Ref.			Ref.			Ref.
Wrong/don't know	NE	—	—	0.59	0.11–3.14	0.532	0.46	0.07–2.85	0.404
Contraceptive knowledge									
Correct			Ref.			Ref.			Ref.
Wrong/don't know	0.94	0.34–2.57	0.905	1.23	0.42–3.59	0.710	0.45	0.11–1.80	0.258
Child-gender preference									
No preference			Ref.			Ref.			Ref.
Preference	1.98	0.81–4.83	0.134	0.54	0.16–1.82	0.323	0.22	0.04–1.09	0.064

Notes: AOR = adjusted odds ratio; CI = confidence interval; Ref. = reference category; NE = not estimable because of complete or quasi-complete separation. All models included N = 160 respondents. Conventional maximum-likelihood AORs, 95% Wald CIs, and two-sided Wald p-values are presented. Statistically significant estimates ($p < .05$) are bolded. Bootstrap robustness check: 1,000 simple bootstrap resamples with 95% percentile intervals were performed.

Model fit:

Outcome 1: $\chi^2(9) = 20.421$, $p = .015$, Nagelkerke $R^2 = .194$, Hosmer–Lemeshow $p = .900$; Outcome 2: $\chi^2(9) = 18.894$, $p = .026$, Nagelkerke $R^2 = .189$, Hosmer–Lemeshow $p = .682$; Outcome 3: $\chi^2(9) = 22.446$, $p = .008$, Nagelkerke $R^2 = .247$, Hosmer–Lemeshow $p = .386$.

The service environment showed the clearest adjusted association with age-related knowledge. Women who reported public facilities as locally available had higher odds of knowing the early and advanced-age thresholds than women who reported informal providers. Public-private-NGO availability was also associated with advanced-age knowledge. These patterns may reflect differences in exposure to trained providers and formal health messages. They do not establish that facility availability caused the knowledge difference.

Birth-spacing knowledge showed a different pattern. Provider knowledge and awareness that PNC is required were associated with correct responses in bivariate analysis, but no stable predictor was independently significant in the adjusted model. The finding does not support the earlier claim that provider knowledge or absence of gender preference had a protective effect. Their confidence intervals included 1. The low event count, wide intervals, and separation further limit interpretation.

Interpretation with previous evidence

The low level of threshold knowledge is plausible in a health-communication environment that often emphasizes service attendance, contraceptive methods, or legal age at marriage rather than the reasons that pregnancy timing matters. National surveys document fertility patterns and care use but do not routinely ask women to state the exact age and interval thresholds examined here (NIPORT & ICF, 2020; NIPORT et al., 2023). The study therefore adds a narrow but policy-relevant measure to the Bangladesh evidence base.

The association with formal service availability is consistent with the broader view that accessibility and provider interaction shape how people understand and use health services. Mamun et al. (2022) highlighted the importance of availability, access, and provider conduct in rural public-health services. Chandra et al. (2020) and Hossain et al. (2017) also showed that reproductive-health knowledge varies across topics and social groups. The present study extends this work to adult rural women and separates age-related knowledge from spacing knowledge.

The unadjusted association between decision-maker's education and awareness of advanced maternal age risks aligns with established household information pathways, wherein educated household heads facilitate health literacy and open dialogue regarding maternal health risks (Ahinkorah et al., 2021; Sarker et al., 2020). However, because this relationship lost statistical significance after adjusting for covariates, education therefore is note being interpreted as an independent predictor in this context. Rather, functional health literacy is more directly driven by individual maternal schooling and direct health system interactions (Uddin et al., 2025). Likewise, while the observed patterns regarding child-gender preference

mirror contemporary evidence linking son preference to contraceptive behavior and fertility timing in Bangladesh (Islam et al., 2019; Rai et al., 2019), the current data do not claim having sufficient statistical power to confirm an independent association.

Conceptual interpretation

The adapted social-ecological framework provides a restrained interpretation of the findings. At the service level, formal-provider availability was associated with age-threshold knowledge. At the household level, decision-maker education and gender preference showed bivariate or suggestive patterns. At the individual level, provider and PNC knowledge were related to birth spacing knowledge before adjustment. The results therefore point to multiple levels of association rather than a single behavioral mechanism.

The framework is interpretive, not confirmatory. The survey did not directly measure beliefs, intentions, self-efficacy, or perceived control. It also did not measure subsequent fertility behavior. Though, the findings cannot demonstrate that knowledge changed practice, they show that specific knowledge outcomes varied across individual, household, and service contexts.

Program implications

Maternal-health counselling should state the thresholds in simple language: pregnancy before age 18, pregnancy after age 35, and at least 24 months from a live birth to the next pregnancy. These messages can be integrated into family-planning, ANC, and PNC contacts. Visual aids and short counselling prompts may help providers deliver the same information consistently.

Communication should extend beyond women. Husbands, mothers-in-law, and other household decision-makers often shape fertility timing and service use. Community sessions can address age-related risk and spacing without assuming that knowledge alone will overcome financial or social constraints. Informal providers should also receive referral-oriented messages because many rural families contact them first. Moreover, NGOs can integrate dissemination of these three messages as a cross-cutting activities in their programs.

Strengths, limitations and future research

A strength of the study is its treatment of three precise knowledge outcomes rather than a single broad score. The multistage community sampling captured four rural settings with contrasting maternal-mortality contexts. However, several limitations are noted in this study. The districts were purposively selected, only four unions were studied. Therefore, the findings do not claim as nationally representative. Besides, self-reported knowledge is often affected by recall, interpretation, or social-desirability bias, and therefore this cross-sectional design supports association only rather than causality identification. On the other hand, the three outcomes had only 30, 26, and 20 correct responses. With nine model parameters, estimates were imprecise and some confidence intervals were very wide. Models 1 and 3 showed separation and did not converge under standard maximum likelihood. Affected coefficients were not interpreted, but the remaining adjusted estimates can be treated as exploratory. Future studies should use larger and probability-based sample size, collect direct measures of communication and household decision-making, and application of penalized or Bayesian methods would be useful for providing more accurate results when events are sparse.

Conclusion

Rural women had limited knowledge of pregnancy before age 18, pregnancy after age 35, and the recommended minimum 24-month interval from a live birth to the next pregnancy. Formal service availability was associated with correct knowledge of the two age thresholds. Birth-spacing knowledge was associated with healthcare provider and PNC knowledge in bivariate analysis, but no stable independent association was identified after adjustment. Maternal-health programs can respond by making pregnancy-timing messages explicitly during family-planning, ANC, and PNC contacts. Communication should also involve household decision-makers and informal providers. The study supports a multilevel approach to reproductive-health knowledge which may changes reproductive behaviors or outcomes.

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Conflict of Interest

The authors declare no commercial or financial relationships that could be construed as a potential conflict of interest.

References

Abate, B. B., Alamaw, A. W., Sendekie, A. K., Tegegne, K. M., Azmeraw, M., Kassaw, A., & Tilahun, B. D. (2024). Prevalence, Determinants, and Complications of Adolescent Pregnancy: An Umbrella Review of Systematic Reviews and Meta-Analyses. *AJOG Global Reports*, *5*(1), 100441. https://doi.org/10.1016/j.xagr.2025.100441 Cited by: 26

Ahinkorah, B. O., Budu, E., Aboagye, R. G., Agbaglo, E., Arthur-Holmes, F., Adu, C., Akonor, P. Y., & Yaya, S. (2021). Factors associated with maternal healthcare utilization in sub-Saharan Africa: A pooled analysis of Demographic and Health Survey data. *PLOS ONE*, *16*(4), e0250188. https://doi.org/10.1371/journal.pone.0250188

Ahrens, K. A., Nelson, H., Stidd, R. L., & Hutcheon, J. A. (2019). Short interpregnancy intervals and adverse maternal outcomes in high-resource settings: An updated systematic review. *Paediatric and Perinatal Epidemiology*, *33*(1), 25–47. https://doi.org/10.1111/ppe.12528

Al-Zubayer, M. A., et al. (2023). Socioeconomic inequalities in maternal and reproductive health literacy among married women in Bangladesh. *Journal of Public Health and Epidemiology*, 15(2), 88–97.

Begum, S., Yasmin, R., & Ferdous, J. (2023). Progress and persisting disparities in maternal health indicators in rural Bangladesh: A decade of Demographic and Health Surveys. *PLOS ONE*, 18(8), e0290051. https://doi.org/10.1371/journal.pone.0290051

Beyene, F. Y., Wudineh, K. G., Bantie, S. A., & Tesfu, A. A. (2025). Effect of short inter-pregnancy interval on perinatal and maternal outcomes among pregnant women in SSA 2023: Systematic review and meta-analysis. *PLOS ONE*, *20*(1), e0294747. https://doi.org/10.1371/journal.pone.0294747

Chanda, S. K., & Jabbar, M. A. (2010). Some differentials of reproductive health of the married women in Bangladesh. *Khulna University Studies*, 10(1&2), 283-292.

Chandra, D., Islam, F., Polly, A., & Golder, B. (2020). Knowledge of reproductive health among adolescent girls at Khulna City Corporation area in Bangladesh. *Khulna University Studies*, 17(1&2), 105-118. https://doi.org/10.53808/KUS.2020.17.1and2.2008-S

Chowdhury, A. M., et al. (2024). Patient experience and communication quality in primary maternal healthcare facilities in rural Bangladesh. *BMC Health Services Research*, 24(1), 312.

Conde-Agudelo, A., Rosas-Bermudez, A., Castano, F., & Norton, M. H. (2012). Effects of birth spacing on maternal, perinatal, infant, and child health: A systematic review of causal mechanisms. *Studies in Family Planning*, 43(2), 93-114. https://doi.org/10.1111/j.1728-4465.2012.00308.x

de Jonge, H. C. C., Azad, K., Seward, N., Kuddus, A., Shaha, S., Beard, J., Costello, A., & Houweling, T. A. J. (2014). Determinants and consequences of short birth interval in rural Bangladesh: A cross-sectional study. *BMC Pregnancy and Childbirth*, 14, 427. https://doi.org/10.1186/s12884-014-0427-6

Directorate General of Health Services. (2024). District Health Information Software 2 maternal-health dashboard [Routine administrative dataset]. *Ministry of Health and Family Welfare, Bangladesh.*

Ganchimeg, T., Ota, E., Morisaki, N., Laopaiboon, M., Lumbiganon, P., Zhang, J., Yamdamsuren, B., Temmerman, M., Say, L., Tuncalp, O., Vogel, J. P., Souza, J. P., & Mori, R. (2014). Pregnancy and childbirth outcomes among adolescent mothers: A World Health Organization multicountry study. *BJOG*, 121(S1), 40-48. https://doi.org/10.1111/1471-0528.12630

Hossain, M. T., Shohel, T. A., Jahan, N., & Sultana, N. (2017). Knowledge of female adolescents about reproductive health in south-western region of Bangladesh. *Khulna University Studies*, 14(1&2), 149-161. https://doi.org/10.53808/KUS.2017.14.1and2.1615-S

Islam, M. Z., Islam, M. M., Rahman, M. M., & Khan, M. N. (2023). Effects of short birth interval on different forms of child mortality in Bangladesh: Application of propensity score matching technique with inverse probability of treatment weighting. *PLOS ONE*, *18*(4), e0284776. https://doi.org/10.1371/journal.pone.0284776

Islam, M. M., Islam, M. K., & Hasan, M. S. (2019). Child gender preference and its influence on fertility intentions and contraceptive use in Bangladesh: Evidence from a national survey. *Journal of Biosocial Science*, *51*(3), 362–377. https://doi.org/10.1017/S002193201800028X

Khandaker, M. A., et al. (2025). Sexual and reproductive health rights: Knowledge, attitude, and practice among adolescents in Dhaka, Bangladesh. *International Journal of Research in Medical Sciences*, 13(1), 45–52.

Launiala, A. (2009). How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi. *Anthropology Matters*, 11(1). https://doi.org/10.22582/am.v11i1.31

Lean, S. C., Derricott, H., Jones, R. L., & Heazell, A. E. P. (2017). Advanced maternal age and adverse pregnancy outcomes: A systematic review and meta-analysis. *PLOS ONE*, 12(10), e0186287. https://doi.org/10.1371/journal.pone.0186287

Mamun, T. M., Chowdhury, S., & Sumi, N. S. (2022). Determinants of satisfactory public health care services in rural Bangladesh. *Khulna University Studies*, 19(1), 128-140. https://doi.org/10.53808/KUS.2022.19.01.2135-S

Mamun, M. A., et al. (2023). Quality of care and patient satisfaction in public health facilities: Evidence from southwestern Bangladesh. *Khulna University Studies*, 20(1), 12–24.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, 15(4), 351-377. https://doi.org/10.1177/109019818801500401

Mistry, S. K., et al. (2024). Household decision-making autonomy and maternal healthcare service utilization in Bangladesh: Evidence from a national cross-sectional study. *PLOS ONE*, 19(3), e0298120.

National Institute of Population Research and Training, ICF, & USAID. (2023). Bangladesh Demographic and Health Survey 2022: Key indicators report. *NIPORT and ICF*.

National Institute of Population Research and Training, International Centre for Diarrhoeal Disease Research, Bangladesh, & MEASURE Evaluation. (2019). Bangladesh Maternal Mortality and Health Care Survey 2016: Final report. *NIPORT, icddr,b, and MEASURE Evaluation*.

Pimentel, J., Ansari, U., Omer, K., Gidado, Y., Baba, M. C., Andersson, N., & Cockcroft, A. (2020). Factors associated with short birth interval in low- and middle-income countries: A systematic review. *BMC Pregnancy and Childbirth*, 20, 156. https://doi.org/10.1186/s12884-020-2852-z

Rahman, M. M., Mistry, S. K., & Islam, M. R. (2022). Progress and remaining challenges in maternal healthcare utilization in Bangladesh: A national overview. *BMC Health Services Research*, *22*(1), Article 812. https://doi.org/10.1186/s12913-022-08182-w

Rai, P., Paudel, S., & Giri, M. (2019). Son preference, parity progression, and contraceptive use in South Asia: A systematic review. *BMC Public Health*, *19*(1), Article 1230. https://doi.org/10.1186/s12889-019-7561-2

Sarker, B. K., Rahman, M., Rahman, T., Rahman, M., Khalil, J. J., Hasan, M., & Mridha, M. K. (2021). Status of maternal and newborn health care services in Bangladesh: Evidence from national surveys and a maternal and newborn health registry. *PLOS ONE, 16(12),* e0260885. https://doi.org/10.1371/journal.pone.0260885

Sarker, B. K., Rahman, M., Rahman, T., Hossain, J., & Khan, A. N. (2020). Decision-making autonomy, spouse's education, and maternal healthcare utilization in rural Bangladesh: A cross-sectional study. *BMJ Open*, *10*(10), e038316. https://doi.org/10.1136/bmjopen-2020-038316

Schummers, L., Hutcheon, J. A., Hernandez-Diaz, S., Williams, P. L., Hacker, M. R., VanderWeele, T. J., & Norman, W. V. (2018). Association of short interpregnancy interval with pregnancy outcomes according to maternal age. *JAMA Internal Medicine*, *178*(12), 1660–1670. https://doi.org/10.1001/jamainternmed.2018.4856

Shi, G., Zhang, B., & Yan, H. (2023). Birth spacing and risk of adverse pregnancy and birth outcomes: A systematic review and dose-response meta-analysis. *Acta Obstetricia et Gynecologica Scandinavica*, *102*(1), 1619–1631. https://doi.org/10.1111/aogs.14660

Story, W. T., & Burgard, S. A. (2012). Couples' reports of household decision-making and the utilization of maternal health services in Bangladesh. *Social Science & Medicine,* 75(12), 2403-2411. https://doi.org/10.1016/j.socscimed.2012.09.017

Sultana, S., et al. (2024). Knowledge gaps in maternal and neonatal danger signs among married women in rural Bangladesh. *Healthcare Access & Public Health*, 8(1), 104–115.

Thayyil, N. A., Radha, S., Kartha, N., Serbin, S., & John, B. (2025). Maternal and fetal outcome in pregnancy with advanced maternal age- a prospective study. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, *14*(10), 3495–3501. https://doi.org/10.18203/2320-1770.ijrcog20252191

Uddin, M. M., Mim, M., & Khan, M. A. I. (2025). Factors affecting maternal mortality and morbidity in Bangladesh. *International Social Research Nexus*, *1*(3), 1–16. https://doi.org/10.63539/isrn.2025016

Uddin, M. S., Hossain, S., & Afsana, K. (2024). Determinants of reproductive health knowledge and behavior among rural women in Bangladesh. *Health Research Policy and Systems,* 22(1), 58. https://doi.org/10.1186/s12961-024-01102-3

World Health Organization. (2007). Report of a WHO technical consultation on birth spacing: Geneva, 13-15 June 2005. WHO.

World Health Organization. (2018). WHO recommendations on antenatal care for a positive pregnancy experience. WHO.

World Health Organization. (2020). *Adolescent pregnancy: Evidence brief*. World Health Organization. https://apps.who.int/iris/handle/10665/329871

World Health Organization. (2023). Trends in maternal mortality 2000 to 2020: Estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. WHO.

Zakaria, M., et al. (2023). Evaluating adolescent sexual and reproductive health knowledge across secondary schools in Bangladesh. *Asian Journal of Medical and Biological Research,* 9(4), 142–151.

Zakaria, M., Karim, F., Mazumder, S., Cheng, F., & Xu, J. (2020). Knowledge on, attitude towards, and practice of sexual and reproductive health among adolescent girls in Bangladesh: An institution-based cross-sectional study. *International Journal of Environmental Research and Public Health,* 17(21), 7720. https://doi.org/10.3390/ijerph17217720