Can programmatic inputs improve adolescent mothers' access to care in rural Bangladesh? Nine-years of evidence from a cohort study

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Abstract

Background

Adolescent mothers (Girls aged 15-19) constitute 8% of annual global births, but account for 10% of annual maternal deaths. WHO recommended 4-8 Antenatal Care (ANC) visits, in addition to quality care and facility-based deliveries, are well-documented interventions to reduce maternal and child morbidity and mortality. Determinants of maternal and child health care in Bangladesh have received considerable attention, but less attention has been focused on adolescent mothers. This study explores the factors associated with 4 or more (4+) ANC visits and facility-based delivery among adolescent mothers in one rural area of Bangladesh,

Methods

This study uses Health and Demographic Surveillance System (HDSS) data. We conducted a comparative study on trends in 4+ ANC visits and facility-based deliveries among adolescent mothers (10-19 years) residing in an intervention area (icddr,b service area, ISA) against a comparison area (government service areas, GSA) of HDSS between 2007 and 2015. 4,996 adolescent mothers were included in the final analysis. Binary logistic regression was used to document the statistical difference on outcome indicators in the two study areas.

Results

Trends in 4+ANC visits and facility-based deliveries were higher in the ISA relative to the GSA. The adjusted odds of an adolescent mother accessing 4+ ANC visits in the GSA, relative to ISA was 0.57 (95% CI: 0.49 – 0.66, p-value <0.05); the adjusted odds of an adolescent mother accessing facility-based delivery in the ISA, relative to GSA was 6.63 (95% CI: 5.85 – 7.52, p-value <0.05). Increasing numbers of ANC visits were associated with increases in facility-based births in both the ISA and GSA.

Conclusion

49   This study documented that both 4+ ANC visits and facility delivery rates among adolescent mothers

50   are much higher in the ISA than GSA. Increasing 4+ ANC visits and facility deliveries over the years,

51   particularly in the ISA, coincide with programmatic efforts to improve the quality and availability of

52   maternal and newborn health services. Learning from existing interventions in ISA and applying them

53   to other areas will strengthen Bangladesh's efforts to improve maternal and newborn health

54   outcomes and achieve the sustainable development goal 3 (SDG 3).

55   **Keywords:** Adolescent pregnancy, Antenatal Care, Facility Delivery, Maternal Health, Bangladesh

Introduction:

Global child birth and adolescent

Adolescent childbearing remains a global concern due to increased health risks and related socio-economic consequences. Adolescent pregnancy is associated with pregnancy complications including anaemia, caesarean delivery, adverse pregnancy outcomes such as premature birth, low birth weight, perinatal mortality and an increased incidence of infant mortality and morbidity [1, 2]. Girls aged 15-19 years account for 10% of global annual maternal deaths, which is disproportionate, as births to adolescent mothers constitute around 8% of all births. The burden is more intense in Lower Middle-Income Countries (LMIC) where about 70,000 adolescents die due to pregnancy and childbirth related conditions each year [3].

Health service accessibility

Poor access to maternity care has been highlighted as one reason for pregnancy-related mortality and morbidity among adolescent mothers, particularly in LMIC [4]. WHO recommends 8 Antenatal Care (ANC) visits for all pregnant women[5]. High quality ANC care, combined with facility-based deliveries, are well-documented interventions that reduce maternal and child morbidity and mortality [6]. Attending periodic ANC initiates opportunities to identify and treat pregnancy risk factors and prepare mothers to attend health facilities for safe delivery [7]. Access to any maternal health services, regardless of maternal age, is low in developing countries. Pregnant women, particularly adolescent mothers, residing in rural regions are less likely to access maternal care [8]. In addition to the availability and accessibility of maternal health services, poor access to care among adolescent mothers have been attributed to their lack of social support, low female autonomy, financial barriers, and a lack of decision-making power [9-11].

Bangladesh and adolescent pregnancy

79   Over the past three decades, unlike other low-income countries, Bangladesh has made significant

80   progress on improving maternal health care indicators; the Maternal Mortality Ratio (MMR) has

81   declined from 320 to 194 per thousand live births, and the Total Fertility Rate (TFR) also declined from

82   3.0 to 2.3[12]. However, adolescent childbearing remains a persistent problem for the nation with the

83   highest fertility rate in South East Asia. In Bangladesh, one in ten girls has a child before the age of and

84   one in three adolescents becomes a mother or pregnant by the age of 19 [13]. Child marriage has

85   traditionally been the leading cause of pregnancies among adolescent girls in Bangladesh [14]. The

86   most recent (2014) Bangladesh Demographic Health Survey (BDHS) data shows that among adolescent

87   mothers, about 20% did not receive any antenatal care while 58% of deliveries took place at home

88   without assistance from skilled attendants [15].

89   **Rational**

90   In line with the global agenda on Sustainable Development Goal (SDG) by 2030, Bangladesh has a

91   renewed focus on adolescents as it as a crucial phase of life in the continuum of care approach [16].

92   To achieve the SDG 3.1 and 3.7, "reduce Maternal Mortality Ratio to 70 per 100,000 live births",

93   adolescent mothers must receive special attention to achieve the SDG [17].   This study explores the

94   factors that were significantly associated with 4+ ANC visits and facility delivery among adolescents'

95   mothers in Matlab, Bangladesh. Additionally, the effects of a maternal health program on increasing

96   access to health care services among adolescent mothers are measured and compared with an area

97   which is solely under the standard government initiatives[18]. The particular advantage of this study

98   is that it uses longitudinal data that provides an accurate estimations of adolescent age in both the

99   intervention and government areas. These study findings have the potential to help policymakers,

100   programmers and researchers to make informed decisions on how investments in improved access to

101   maternal health services for adolescent mothers could contribute overall improvement in maternal

102   health care in Bangladesh.

103 **Methodology**

104 **Study Design:**

105 A retrospective longitudinal study, where data from the Health and Demographic Surveillance System

106 (HDSS) run by the International Centre for Diarrhoeal Disease Centre (icddr,b), was used to analyze

107 access to ANC care among adolescent mothers in both the icddr,b and government areas. The overall

108 aim was to explore the determinants of and compare trends in facility-delivery and 4+ANC visits

109 among adolescent mothers in the icddr,b intervention and government intervention areas.

110 **Study population:**

111 Women, in the HDSS database, who gave birth below the age of 20 years between 2007 and 2015

112 were the study population. In total 5,774 adolescent mothers, who gave birth between 10 and 19

113 years were identified. Availability of complete data on ANC care and delivery locations as well as

114 pregnancy lasting >=28 weeks gestation were the major inclusion criteria. This resulted in a final

115 sample of 4,996 (87% of identified women who gave birth between the ages of 10 and 19) had

116 complete data; 2,892 from icddr,b Service Area (ISA) and 2,104 from Government Service Area (GSA).

117 **Study setting:**

118 The Health and Demographic Surveillance System (HDSS) has been running in Matlab since 1966.

119 Matlab is a rural area, located 55 kilometers southeast of Dhaka. icddr, b has been collecting vital

120 statistics (live births, stillbirths, miscarriages, deaths, marriages/dissolution and in and out-migration)

121 through community health research workers (CHRWs) since 1966 [19]. The CHRWs collect vital

122 demographic data by visiting each household on a bi-monthly basis. At each visit CHRWs complete

123 vital event registration forms.

124

125 The Matlab HDSS area is divided into two parts as seen in **Figure 1**: the icddr,b service area (ISA:

126 administrative blocks A, B, C & D) and the government service area (GSA: administrative blocks E, F &

127 G), covering 142 villages since 1987. In 2007, the Maternal, Neonatal and Child Health (MNCH) Project

128   was embedded in the on-going MCH -FP Project in the ISA and has worked to increase the proportion

129   of facility-based deliveries and to introduce an evidence-based maternal & neonatal package which

130   provides services throughout the pregnancy continuum till 6 months after delivery [18]. In addition to

131   documenting vital events, CHRWs in the ISA were trained to provide basic maternal health care,

132   information on contraception and contraceptives, and immunizations for mothers and children under

133   the MCH -FP Project. Each administrative block in the ISA serves a population of about 27,000 and

134   each has sub-centre hospital staffed by midwives who provide 24/7 delivery care and related services.

135   These sub-centre hospitals are directly linked with the MCH - FP clinics in the Matlab Township, which

136   is staffed by doctors & nurses to provide basic obstetric care round the clock [20]. In the Matlab

137   hospital, every delivery follows standard clinical guidelines prepared by the Obstetrics and

138   Gynaecology Society of Bangladesh (OGSB) & Lamb Hospital [21].

139

140   In the GSA administrative block (E,F & G) there is a population of 115,000, and only standard

141   government services are provided. The GSA has three government Family Welfare Centres (FWCs)

142   where a family welfare visitor (FWV) is posted to serve the MNCH services to the respective

143   population. They provide ANC, postnatal care (PNC), delivery care, TT injections and child vaccinations.

144   Their services are available 24/7. If a pregnancy is complicated and out of a FWV's capacity to deal

145   with they refer the mother to the Upazilla Health Complex (UHC) which is the nearest higher referral

146   point for each FWC. In both areas, pregnancies are identified by a pregnancy strip test using a morning

147   urine sample.

148   **Figure 1: Matlab Study setting**

149   Data collection in icddr,b service area (ISA) and Government service area(GSA):

150   The HDSS collects routine data from both the ISA & GSA. There are two groups of CHRWs in the ISA:

151   Surveillance CHRWs (n=43) and Service CHRWs (n=41). In the ISA, both types of CHRWs are available;

152   in the government area, only surveillance CHRWs are available. Service CHRWs collect data through

153   monthly visits to each household. Surveillance CHRWs visit each household at a two months' interval.

154 CHRWs collect data using a register book named the "Service Record Book" (SRB) and these records

155 are collected electronically using hand-held tablets. In the ISA, CHRWs collect data on reproductive

156 events (menstrual status, pregnancy and outcome status, lactation status, contraceptive use, under-

157 five children's diarrhoea and pneumonia history of last two weeks), the immunization status of eligible

158 women and their under-5 children. All services provided to eligible mothers and children are recorded

159 in a family visit record (FVR) book for every household in the ISA. In each FVR, all data are recorded

160 for each member of the household. Each CHRW carries these electronic Tablets with her during her

161 field visits and covers 24 households in a month and 410 couples in 18 months. During their (CHRWs)

162 visit, if a woman is found in her missing period for - one and half months, then the CHRW performs a

163 urine test for pregnancy and gives her a Health Service card and asks the woman to visit the sub-centre

164 clinic (each block has one sub-centre clinic) for further care. At the sub-centre, the midwives provide

165 a full range of services (antenatal care and postnatal care, counselling on pregnancy risks, deliveries,

166 keeping of all records, and referral of patients to the Matlab hospital if required). Midwives are fully

167 qualified nurses or midwives and CHRWs have at least passed class ten [19]. icddr,b has deployed 6

168 CHRWs for each block solely for surveillance data collection since 1966. Each CHRW completes data

169 collection from 1200 households every two months.

170 **Quality of the data:**

171 Each CHRW area is annually assigned at the beginning of the year. Each month all CHRWs sit together,

172 in both the icddr,b and government service areas to update their registrar books. The supervisor

173 routinely provides spot checks of a 2% sample. After going through three tiers of supervision by Field

174 Research Supervisors (FRSs) and Field Research Officers (FRO), and a senior manager respectively on

175 the field and then processing through an error detecting program at the central office. All cleaned

176 data are stored within the longitudinal data system and checked with a set of validation before final

177 storage.

178 **Data analysis:**

179 Quantitative data was analyzed using SPSS 23 statistical software. The outcome variables were healthy

180 health-seeking behaviour among adolescent mothers. Healthy behaviour was defined as follows: 1,

181 Attending 4+ ANC visits; 2, Having a facility-based delivery in either a government or non-government

182 facility. The independent variables covered socio-demographic and general characteristics of the

183 mothers as well as the distance to the nearest facility. Economic status was measured in asset quintiles

184 rather than in terms of income or consumption in the study area [22, 23]. Assets included durable

185 goods (e.g., table, chair, watch, television, or bicycle), housing facilities (e.g., type of toilet, or source

186 of drinking water), housing materials (e.g., type of wall or roof), and possession of farming land. Socio-

187 economic survey data of the year 2014 was used to construct asset quintiles. Socio-demographic

188 differences between these two service areas were measured through chi-square tests for categorical

189 variables and t-tests for the quantitative variables. The distribution of 4+ ANC visits and facility-based

190 deliveries among adolescent women from 2007 to 2015 was explored for both the areas. The

191 predictors associated with healthy pregnancy behaviors and having a facility delivery were determined

192 through binary logistic regression analysis and adjusted for socio-demographic variables. Statistical

193 significance was defined as p-values of <0.05.

194 **Results:**

195 The Socio-demographic characteristics of adolescent mothers are described in Table 1.

196 **Table 1: Socio-demographic characteristics of adolescent mothers in both icddr,b service area (ISA)**

197 **and Government service area (GSA)**

Socio-demographic Variables	ISA (2892)	GSA (2104)	p-value
	n (%)	n (%)	
Maternal education			
No education	83 (2.9)	74 (3.5)	
Primary	472 (16.3)	431 (20.5)	<0.001*
Above Primary	2337 (80.8)	1599 (76.0)	

Paternal education			
No education	1270 (43.9)	905 (43.0)	
Primary	600 (20.7)	511 (24.3)	0.008*
Above Primary	1022 (35.3)	688 (32.7)	
Religion			
Islam	2570 (88.9)	1963 (93.3)	<0.001*
Hindu	322 (11.1)	141 (6.7)	
Asset Score			
Lowest	454 (15.7)	324 (15.4)	
Second	545 (18.8)	403 (19.2)	
Middle	525 (18.2)	417 (19.8)	0.090
Fourth	644 (22.3)	499 (23.7)	
Richest	724 (25.0)	461 (21.9)	
Parity			
Nullipara	46 (1.6)	43 (2.0)	
1	2749 (95.1)	1922 (91.3)	<0.001*
2	97 (3.4)	139 (6.6)	
Place of Delivery			
Home	549 (19.0)	1262 (60.0)	<0.001*
Facility	2343 (81.0)	842 (40.0)	

198 **Note: * indicates that the results are significant at P-value < 0.05**

199

200 Among the 4,996 adolescent mothers, more than 90% had completed at least primary education or

201 higher, which is greater than the percentage of father's primary and higher education level. In both

202 areas, adolescent mothers are predominantly Muslim and most of the adolescent mothers had a

203 parity of one. Facility deliveries were more than double in the icddr,b service area (ISA) relative to the

204 government service area (GSA).

205 **Figure 2: Distribution of 4+ ANC visits in both icddr,b service area and Government service area**

206 **among adolescent mothers (Matlab Bangladesh: 2007-2015).**

207 Figure 2 shows the distribution of 4+ ANC visits in both ISA) GSA). the rate was higher in GSA till 2012

208 but started to fall after that the year the 4+ ANC attendance became higher in ISA (22%) than the GSA

209 (16%) on 2013 the gap in service coverage has continued to increase since 2014 onwards.

Table 2: Factors associated with 4+ ANC visits: results from bivariate and multivariate analysis

211

	4+ ANC Visits			Adjusted Effects		
	No (N = 4292)	Yes (N =704)	P-value	Adjusted OR	95% CI	P-value
	n(%)	n(%)				
Service Area						
icddr,b Service Area (ISA)	2467 (85.3)	425 (14.7)	0.150	Ref	--	--
Government Service Area (GSA)	1825 (86.7)	279 (13.3)		0.57	0.49 – 0.66	<0.001*
Maternal Education						
No Education	146 (93.0)	11 (7.0)	<0.001*	0.39	0.20 - 0.72	0.003*
Primary	807 (89.4)	96 (10.6)		0.72	0.56 - 0.91	0.007*
Above Primary	3339 (84.8)	597 (15.2)		Ref	--	--
Paternal Education						
No Education	1852 (85.1)	323 (14.9)	0.006*	0.49	0.43 – 0.57	<0.001*
Primary	987 (88.8)	124 (11.2)		0.48	0.38 - 0.59	<0.001*
Above Primary	1453 (85.0)	257 (15.0)		Ref	--	--
Religion						
Islam	3918 (86.4)	615 (13.6)	0.001*	Ref	--	--
Hindu	374 (80.8)	89 (19.2)		0.95	0.73 - 1.22	0.673
Asset Score						
Lowest	693 (89.1)	85 (10.9)	<0.001*	0.31	0.24 – 0.40	<0.001*
Second	831 (87.7)	117 (12.3)		0.31	0.25 – 0.39	<0.001*
Middle	814 (86.4)	128 (13.6)		0.33	0.27 – 0.41	<0.001*
Fourth	977 (85.5)	166 (14.5)		0.34	0.28 – 0.40	<0.001*
Richest	977 (82.4)	208 (17.6)		Ref	--	--
Repeated Pregnancy						
Yes	272 (85.8)	45 (14.2)		0.71	0.51 – 0.99	0.049*
No	4020 (85.9)	659 (14.1)	0.956	Ref	--	--

212 **Note: * indicates that the results are significant at P-value < 0.05**

213

214   Table 2 shows the results from bivariate and multivariate findings on the determinants of 4+ ANC

215   among adolescent mothers. The adjusted model included area of residence (ISA vs. GSA), maternal

216   education, paternal education, religion, asset score, repeated pregnancy and distance from nearest

217   facility.

218   Bivariate findings revealed that maternal education, paternal education, religion, and asset scores

219   were significantly related to 4+ ANC visits. In total 704 adolescent mothers from both ISA and GSA had

220   received 4+ ANC. It is seen that the percentage of mothers from ISA (14.7%) who received 4+ ANC was

221   (p-value < 0.05) higher than the mothers from GSA (13.3%). Only 15.2% of adolescent mothers with

222   the above primary education received 4+ ANC from both areas.

223   Table 2 also shows that the adjusted odds of 4+ ANC visits among adolescent mothers was 43% lower

224   in GSA (OR= 0.57, 95% CI: 0.49 – 0.66, p-value < 0.05) compared to that of ISA. Adolescent mothers

225   with no education (OR = 0.39, 95% CI: 0.20 – 0.72, p-value < 0.05) and primary education (OR = 0.72,

226   95% CI: 0.56 – 0.91, p-value < 0.05) were less likely to receive 4+ ANC compared to adolescent mothers

227   having above primary education. Similar trends found for paternal education. People from Hindu

228   communities (OR= 0.95, 95% CI: 0.73 – 1.22) were less likely to receive four or more ANC than Muslims

229   though the results were not significant. Asset scores were also found to be a significant determinant

230   for receiving 4+ ANC. Poorest adolescent mothers were less likely to receive 4+ ANC (OR = 0.31, 95%

231   CI: 0.24 – 0.40, p-value < 0.05) compared to richest adolescent mothers. Similar behaviour found in

232   adolescent women of other asset score groups compared to the richest group.

233   **Figure 3: Distribution of Facility Delivery among adolescent mothers in icddr,b service area and**

234   **Government service area (Matlab Bangladesh: 2007-2015)**

235   Figure 3 shows the distribution of facility deliveries among adolescent mothers in both ISA) and GSA).

236   The percentage of adolescent mothers having facility deliveries in the ISA was consistently higher than

237   in the GSA. Facility deliveries among adolescent mothers increased in both ISA and GSA between 2007

238   and 2015.

239   **Table 3: Factors associated with getting facility delivery: results from bivariate and multivariate**

240   **analysis**

	Facility Delivery			Adjusted Effects		
	No (N= 1811) n(%)	Yes (N= 3185) n(%)	P-value	Adjusted OR	95% CI	P-value
Service Area						
icddr,b Service Area (ISA)	549 (19.0)	2343 (81.0)	<0.001*	6.63	5.85- 7.52	<0.001*
Government Service Area (GSA)	1262 (60.0)	842 (40.0)		Ref	--	--
Maternal Education						
No education	67 (42.7)	90 (57.3)		0.77	0.53 – 1.11	0.165
Primary	474 (52.5)	429 (47.5)	<0.001*	0.51	0.43 – 0.61	<0.001*
Above Primary	1270 (32.3)	2666 (67.7)		Ref	--	--
Paternal Education						
No education	735 (33.8)	1440 (66.2)		1.05	0.92 – 1.20	0.464
Primary	519 (46.7)	592 (53.3)	<0.001*	0.73	0.62 - 0.87	0.001*
Above Primary	557 (32.6)	1153 (67.4)		Ref	--	--
Religion						
Islam	1669 (36.8)	2864 (63.2)	0.009*	Ref	--	--
Hindu	142 (30.7)	321 (69.3)		1.13	0.89 - 1.44	0.307
Asset Score						
Lowest	348 (44.7)	430 (55.3)		0.55	0.45 – 0.67	<0.001*
Second	362 (38.2)	586 (61.8)		0.71	0.59 – 0.86	<0.001*
Middle	388 (41.2)	554 (58.8)	<0.001*	0.59	0.49 – 0.70	<0.001*
Fourth	399 (34.9)	744 (65.1)		0.75	0.64 – 0.88	<0.001*
Richest	314 (26.5)	871 (73.5)		Ref	--	--
No. of ANC Visits						
Less than 4	1647 (38.4)	2645 (61.6)	<0.001*	Ref	--	--
4+	164 (23.3)	540 (76.7)		2.04	1.67 – 2.49	<0.001*
Repeated Pregnancy						
Multiple	128 (40.4)	189 (59.6)	0.114	0.90	0.69 - 1.18	0.450
Single	1683 (36.0)	2996 (64.0)		Ref	--	--

241 **Note: * indicates that the results are significant at P-value < 0.05**

242 Table 3 illustrates the determinants associated with receiving facility delivery in ISA and GSA

243   Bivariate findings demonstrated that 3185 adolescent mothers from both ISA and GSA accessed

244   facility deliveries. Service area, maternal education, paternal education, religion, asset score, and

245   increased number of ANC visits were found to be significant predictors of facility-based deliveries

246   among adolescent mothers (p-value < 0.05). 80.0% of adolescent mothers in ISA had accessed facility

247   delivery whereas in GSA only 40.0% had accessed for the same. Less than 50% of primary educated

248   adolescent mothers' and roughly 67.7% of adolescent mothers' with higher education received facility

249   delivery. In addition, 53.3% of fathers with primary education and 67.4% of fathers with higher

250   education assisted their wives to receive facility based deliveries. 76.7% of adolescent mothers from

251   both areas who had received 4+ ANC also received facility-based delivery care.

252   The adjusted odds of receiving facility-based delivery among adolescent mothers was almost 6 times

253   higher in ISA compared to that of GSA (OR = 6.63, 95% CI: 5.85 – 7.52), p-value < 0.05). Poorest

254   adolescent mothers (OR = 0.55, 95% CI: 0.45 – 0.67, p-value < 0.05) were less likely to receive facility

255   deliveries compared to richest. Other asset score groups of adolescent mothers also have shown the

256   same behaviour compared to the richest group in receiving facility delivery. Adolescent mothers who

257   received 4+ ANC during pregnancy were more likely to receive facility delivery service compared to

258   those who did not receive 4+ ANC (OR = 2.04, 95% CI: 1.67 – 2.49, p-value <0.05) (Table-3).

259   To visualize the effect of the practice of 4+ ANC visits on receiving facility delivery in ISA and GSA

260   separately we have done two logistic regression analyses using data from ISA and GSA separately.

261   Findings showed (data not shown) that adolescent mothers who received 4+ ANC during pregnancy

262   were more likely to receive facility delivery service compared to those who did not received 4+ ANC

263   in both ISA (OR = 3.33, 95% CI: 2.39 – 4.62, p-value <0.05) and GSA (OR = 1.96, 95% CI: 1.52 – 2.53, p-

264   value < 0.05).

265   **Discussion:**

266 This study documented that the uptake of 4+ ANC visits and facility-based deliveries are higher among

267 adolescent mothers residing in the icddr,b area relative to the government area. The inbuilt nature of

268 the MNCH service delivery in the icddr,b area could be a factor contributing to this [18]. Receiving 4+

269 ANC visits during pregnancy is an important predictor of adolescent mothers delivering their babies in

270 facilities for both areas; however, the association between 4+ ANC visits and receiving facility delivery

271 were stronger in ISA than GSA in this study.

272 Four or more ANC visit found to be more likely to happen in ISA than GSA. This rate is much higher

273 than other reported studies [24, 25]. This is probably attributable to the quality of ANC services, which

274 have improved patient knowledge and recognition of pregnancy danger signs, and referral. These

275 factors support increasing 4+ ANC visits and facility delivery in the ISA compare to GSA, as was

276 observed in a 2011 Matlab MNCH study [18]. For this study, adolescent mothers who practice 4+

277 ANC uptake during pregnancy are more likely to receive facility delivery service which is similar to

278 other developing countries [26]. ISA is providing more evidence based services than GSA. The list of

279 ISA services can be found in the Matlab MNCH study[18]

280 Low performances of GSA compare to ISA could be the community skilled birth attendant (CSBA)
281 programme initiated 2003 in Bangladesh. The CSBA programme trained the Female Health Assistants
282 (FHA) from DGHS and Family Welfare Assistant (FWA) from DGFP for six months on safe delivery. they
283 used to attend delivery at home which causes detract their day to day home visits for organizing MNCH
284 services[27]. This was also reported increasing the number of CSBA and also decreasing the household
285 visit by FWA and FHA in BDHS 2016[25]. But this was not case in ISA. So, lack of contact and
286 communication of the GSA filed workers rather busy with home delivery might reduce the
287 performances for ANC and delivery care in GSA.

288 Significant determinants of receiving facility delivery in both ISA and GSA were maternal education,

289 paternal education, higher asset scores, religion, number of ANC visits and distance from nearest

290 facility. However, the percentage of receiving facility-based delivery was higher among ISA compared

291 to GSA even when controlling for these factors. This suggests that icddr,b interventions in the ISA

292 have contributed to improved adolescent maternal health behavior

293   As per earlier studies, educated mothers are more likely to take advantage of public health care

294   services, seek high-quality services and have greater ability to use health care inputs that offer

295   improved care than women with no education [28, 29]. Findings revealed an important impact of

296   maternal education on the practice of healthy behaviours among adolescent mothers for this study.

297   However, this study suggests that adolescent mothers, whose husbands had higher educational levels,

298   were more likely to receive maternal health services than others were. These findings are similar to

299   other studies [30, 31].

300   For this study, the Hindu community was less likely to visit 4+ ANC and but more likely to receive

301   facility delivery than Muslim community, though the result was insignificant (which might be a result

302   of sampling fluctuation). These findings are inconsistent with that of an earlier study, which

303   highlighted that Hindu and Muslim women are similar in availing of delivery care [32]. The findings

304   revealed inequities in receiving 4+ ANC and facility delivery by socioeconomic strata in Matlab

305   Bangladesh. The economic barriers to maternal health care are still a key determinant to accessing

306   the services in the study area. Richest people were more likely to receive 4+ ANC visits as well as

307   facility delivery than poor in both areas which are a common scenario across different countries of the

308   developing world [33, 34]. This finding suggests financial barriers may influence health service

309   utilization for adolescent mothers to achieve universal health coverage in the context of Bangladesh

310   [35].

311   **Strengths and limitations:**

312   Data from Matlab HDSS has been criticized for not being representative of other rural areas of

313   Bangladesh because of its many and long-term interventions in the field of health, population and

314   nutrition [36]. Additionally, the current Matlab data collection system does not allow monitoring of

315   the WHO recommended 8 ANC visits. Finally, it has been noted that that GSA CHRWs have a much

316   larger catchment population than ISA CHRW's, which may result in less robust GSA data. However,

317   the data quality systems that are in place in both the ISA and GSA support and robustness of Matlab

318   surveillance data, and is the main strength of this paper. The rigor of the data quality procedures, long-

319   standing follow up in nature of the HDSS has provided a unique opportunity to produce authentic

320   results from the analysis [19].

321   **Conclusion:**

322   Enhanced 4+ ANC visits and a higher prevalence of facility deliveries indicate that interventions in the

323   ISA are supporting adolescent mothers' access to maternal care. Interventions implemented in ISA, if

324   scaled, have the potential to ensure that every adolescent mother received the best standard of care,

325   regardless of economic status and residence of pregnant women. Reducing the prevalence of

326   adolescent pregnancies, and ensuring all pregnant adolescents reach care will support for

327   Bangladesh's national strategic guidelines, and the achievement of SDG 3.8 which refers essential

328   health service should be available to all respective persons by 2030[35].

329   **List of abbreviations**

330   ANC: Antenatal Care, BDHS: Bangladesh Demographic And Health Survey, CHRW: Community Health

331   Research Worker, CI: Confidence Interval, CSBA: Community Skill Birth Attendant, DGFP: Director

332   General of Family Planning, DGHS: Director General of Health Service, FHA" Female Health Assistant,

333   FRO: Field Research Officer, FRS: Field Research Supervisor, FVR: Family Visit Record, FWA: Family

334   Welfare Assistant, FWV: Family Welfare Visitor, GIS: Geographical Information System, GSA:

335   Government Service Area, HDSS: Health and Demographic Surveillance System, icddr,b: International

336   Centre for Diarrhoeal Research, Bangladesh, ISA: icddr,b Service Area, LMIC: Lower Middle Income

337   Country, MCH-FP: Maternal and Child Health and Family Planning, MMR: Maternal Mortality Ratio,

338   MNCH: Maternal Neonatal and Child Health, OGSB: Obstetrics and Gynecology Society of Bangladesh,

339   OR: Odds Ratio, SDG: Sustainable Development Goal, SPSS: Software Package for Social Statistics, SRB:

340   Service Record Book, TFR: Total Fertility Rate, UHC: Upazila Health Complex, UHFWC: Upazila Health

341   and Family Welfare Centre, WHO: World Health Organization,

Ethics approval and consent to participate:

The institutional review committee at icddr,b provided ethical clearance for this analysis. Data were accessed in compliance with icddr,b's published data policies. The confidentiality and anonymity of study participants were strictly maintained. Data were presented in such a way so that any person cannot be identified or traced back through the reported presentation of the information.

Availability of data and materials:

Data contain potentially identifying or sensitive information from delivering women. However, "Data can be available on request". The data request should be submitted to the Research Administration (RA) of iccdr,b and will be assessed by the corresponding Ethics committee named institutional Review Board of icddr,b. As a supplementary information, we have added approved protocol where you can get the study title and protocol number (PR-17087) against which data access application should b made. Please visit https://www.icddrb.org/ dmdocuments/icddrb%20Data%20Access% 20Policy.pdf for additional information. Data requests are evaluated by icddr,b's Data Repository Committee (DRC) and the Research Administration (RA) serves as the Secretariat of the DRC. The key contact person of RA at present is Ms. Armana Ahmed, Lead (A), RA at aahmed@icddrb.org If the data request is considered justifiable by the DRC then RA will share the anonymous data with the applicant. Moreover, for any particular clarification of the research findings that is documented in this article, queries can be directed to the primary author of this article or to the corresponding author. Both of them can be accessed at draminur@icddrb.org. The email correspondence regarding data access could be done at the executive director office at dircetor@icddrb.org.

Competing Interests

The author reports no conflicts of interest in this work.

374 **Author contributions**

375 AR has conceptualized the study and AR, TB, MH, AA, NA, IA and ST designed the methods. AR, TB,

376 MH, NA, IA, and ST were involved with the implementation process. AR, TB, MH, IA, AA, NA and ST led

377 the data analysis, interpretation of results and development of the first draft. All the authors

378 contributed toward drafting and revising the paper and agree to be accountable for all aspects of the

379 work.

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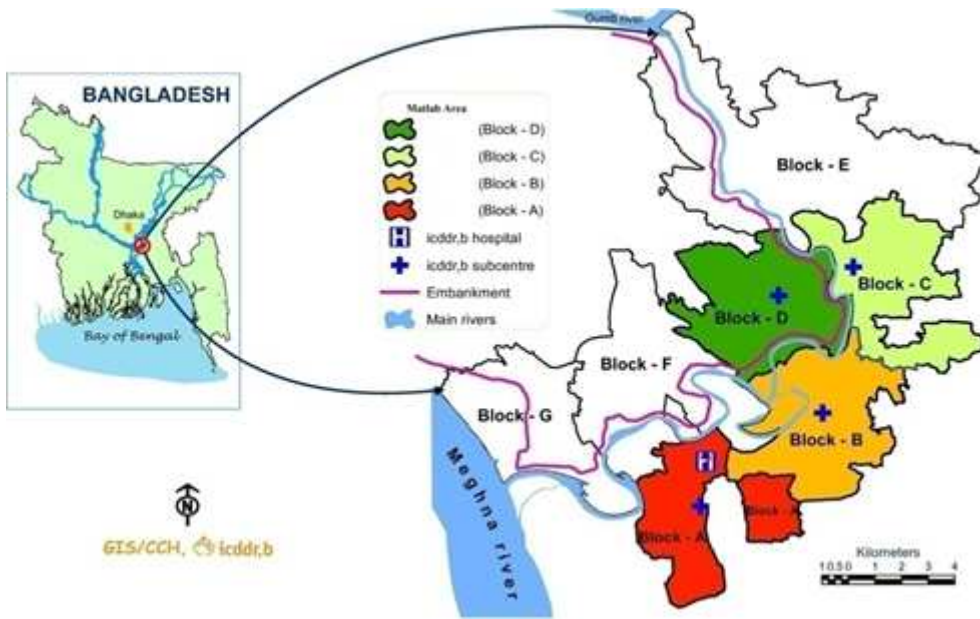462   p. 1275.
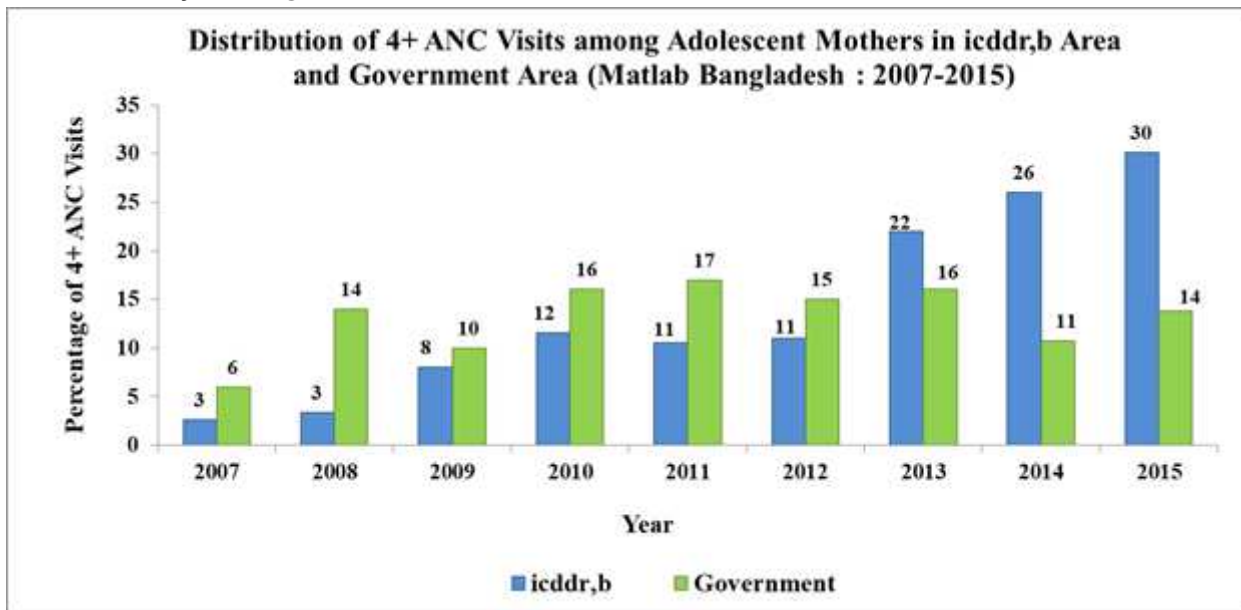
Figures

Figure 1

Matlab Study setting

Figure 2

Distribution of 4+ ANC visits in both icddr,b service area and Government service area among adolescent mothers (Matlab Bangladesh: 2007-2015).
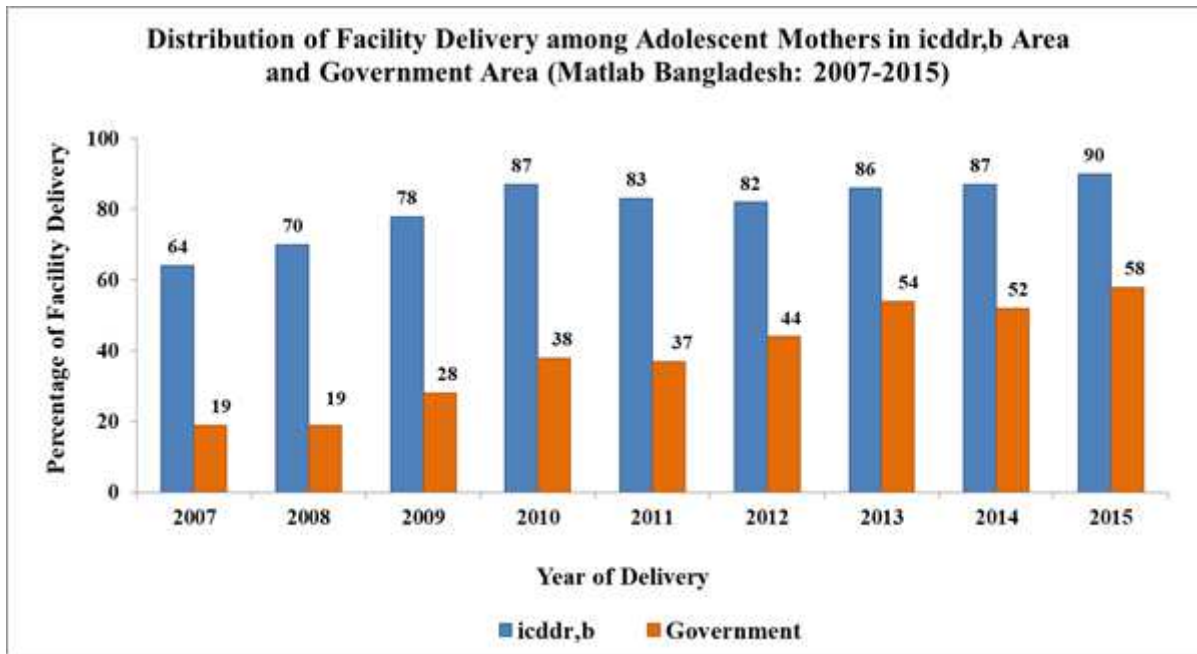
Figure 3

Distribution of Facility Delivery among adolescent mothers in icddr,b service area and Government service area (Matlab Bangladesh: 2007-2015)