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Determinants of utilization of antenatal and delivery care at the community level in rural Bangladesh
--Manuscript Draft--

Manuscript Number:	PONE-D-21-17032
Article Type:	Research Article
Full Title:	Determinants of utilization of antenatal and delivery care at the community level in rural Bangladesh
Short Title:	Determinants of utilization of maternal care at the community level in rural Bangladesh
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Keywords:	Antenatal Care, Facility Delivery, Timely first ANC, Timely four ANC visits, Cross-sectional study
Abstract:	Background: Timely utilization of antenatal care and delivery services supports the health of mothers and babies. This study aims to assess the utilization, timeliness of, and socio-demographic determinants of antenatal and delivery care services in two sub-districts in Bangladesh. Methods: This cross-sectional study used data collected through a structured questionnaire in the eRegMat cluster-randomized controlled trial, which enrolled pregnant women between October 2018-June 2020. Bivariate and multivariate logistic regression were employed. To determine the associations of socio-demographic variables with timely first ANC, four timely ANC visits, and facility delivery, binary logistic regression was executed. Results: Data were available on 3293 pregnant women. Attendance at a timely first antenatal care visit was 59%. Uptake of four timely antenatal care visits was 4.2%. About three-fourths of the women delivered at a health facility. Women from all socioeconomic groups gradually shifted to utilizing private hospitals from the public health facilities, as the pregnancy advanced. Timely first antenatal care visit was associated with: women over 30 years of age (AOR: 1.52, 95% CI: 1.05 - 2.20), nulliparity (AOR: 1.30, 95% CI:1.04 -1.62), husbands with >10 years of education (AOR: 1.40, 95% CI: 1.09 - 1.81), being in the highest wealth quintile (AOR: 1.49, 95% CI: 1.18 - 1.89). For facility delivery, women's age, parity, women's education, husband's education, and wealth index were found to be determinants. None of the available socio-demographic factors were associated with four timely antenatal care visits. Conclusions: The study observed socio-demographic inequalities associated with increased utilization of timely first antenatal care visit and facility delivery. The majority of women did not utilize one type of health facility for their antenatal care visits and delivery. Maternal health care programs should prioritize women who have husbands with low education, are of low socioeconomic status, young age, and multiparity to increase the health service utilization and promote good health.
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This research is part of the eRegistries Bangladesh project funded by the Norwegian Research Council (grant agreement number 248073/H10; title: Strengthening the extension of Reproductive, Maternal, Newborn, and Child Health services in Bangladesh with an electronic health registry: A cluster randomized controlled trial), and the Centre for Intervention Science in Maternal and Child Health (CISMAC), Center for International Health, University of Bergen (project number: 223269). icddr,b is also grateful to the Governments of Bangladesh, Canada, Sweden and the UK for providing core/unrestricted support. The funders had no role in the design of the study and collection, analysis, and interpretation of data.

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The study was approved by the Research and Ethical Review Committees of the International Centre for Diarrhoeal Disease Research, Bangladesh, and the Regional Ethical Committee in Norway, Southeast region. All participants received an explanation of the purpose of the study and gave written informed consent for participation in the study.

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2   in rural Bangladesh

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Abstract

Background: Timely utilization of antenatal care and delivery services supports the health of mothers and babies. This study aims to assess the utilization, timeliness of, and socio-demographic determinants of antenatal and delivery care services in two sub-districts in Bangladesh.

Methods: This cross-sectional study used data collected through a structured questionnaire in the eRegMat cluster-randomized controlled trial, which enrolled pregnant women between October 2018-June 2020. Bivariate and multivariate logistic regression were employed. To determine the associations of socio-demographic variables with timely first ANC, four timely ANC visits, and facility delivery, binary logistic regression was executed.

Results: Data were available on 3293 pregnant women. Attendance at a timely first antenatal care visit was 59%. Uptake of four timely antenatal care visits was 4.2%. About three-fourths of the women delivered at a health facility. Women from all socioeconomic groups gradually shifted to utilizing private hospitals from the public health facilities, as the pregnancy advanced. Timely first antenatal care visit was associated with: women over 30 years of age (AOR: 1.52, 95% CI: 1.05 - 2.20), nulliparity (AOR: 1.30, 95% CI:1.04 -1.62), husbands with >10 years of education (AOR: 1.40, 95% CI: 1.09 - 1.81), being in the highest wealth quintile (AOR: 1.49, 95% CI: 1.18 - 1.89). For facility delivery, women's age, parity, women's education, husband's education, and wealth index were found to be determinants. None of the available socio-demographic factors were associated with four timely antenatal care visits.

Conclusions: The study observed socio-demographic inequalities associated with increased utilization of timely first antenatal care visit and facility delivery. The majority of women did not utilize one type of health facility for their antenatal care visits and delivery. Maternal health care programs should prioritize women who have husbands with low education, are of low socioeconomic status, young age, and multiparity to increase the health service utilization and promote good health.

42   **Trial registration:** ISRCTN69491836. Registered on December 06, 2018. Retrospectively registered.

43   **Keywords:** Antenatal Care, Facility Delivery, Timely first ANC, Timely four ANC visits, Cross-sectional

44   study

45   Introduction

46   Timely utilization of antenatal care (ANC) and delivery services is important to support maternal health

47   and allow for the best possible start to babies' lives. Most pregnancy complications leading to severe

48   morbidity or mortality can be prevented or treated if women use healthcare services provided by skilled

49   providers with the necessary resources according to recommended clinical guidelines [1]. Utilization of a

50   health facility during pregnancy allows for recognition of warning signs of complications, referral

51   mothers to emergency care, and management of severe complications during pregnancy and childbirth.

52   Despite progress in maternal health service utilization in some low- and middle-income countries,

53   further increase in utilization is needed to impact maternal and neonatal health [2].

54   Bangladesh has decreased maternal and neonatal mortality remarkably from 1990 to 2018. Maternal

55   mortality reduced from 570 to 196 per 100,000 live births during that period [3]. For the same period,

56   neonatal mortality reduced from 59 to 30 per 1000 live births [4, 5]. However, the levels of maternal and

57   neonatal mortality have remained stagnant since 2015, the end of Millennium Development Goal (MDG)

58   era. Sustainable Development Goal 3 emphasizes the end of all preventable deaths and sets the target

59   to reduce the maternal mortality ratio to less than 70 per 100,000 live births and neonatal mortality to

60   at least as low as 12 per 1,000 live births by 2030 [6]. To achieve these targets, better health care

61   utilization in both pregnancy and delivery are essential.

62   ANC utilization is a crucial step for timely identification, prevention, and management of factors

63   influencing pregnancy outcomes [7-9]. While significant progress has been shown worldwide in the use

64   of health facilities during childbirth (77%) [10], only about 64% of women receive four or more ANC

65   visits [11, 12]. Late initiation of ANC is one reason for underutilization of care, subsequently leading to

66   increased risk of adverse pregnancy outcomes [9, 11]. ~~Increased utilization of timely ANC services~~

67   ~~facilitates women and their family's introduction to the formal health system, promoting early risk~~

68   ~~identification and improving pregnancy outcomes.~~

69   In Bangladesh, the ~~utilization~~ of health facilities for ANC and childbirth has been steadily increasing over

70   the years. About 47% of women receive four or more ANC visits. However, only 29% of women receive a

71   first ANC visit before 16 weeks and 17% of pregnant women still do not receive any ANC. About half of

72   all deliveries occur in health facilities, most of them privately-owned [5]. The use of public and non-

73   governmental health facilities for childbirth has increased but to a lesser extent. There is considerable

74   inequalities in the utilization of maternal health services in the different sub-districts of Bangladesh [13].

75   A recent cross-sectional study conducted in a sub-district of the Noakhali district found lower utilization

76   of ANC services (34.6%) and facility delivery (5.3%) compared to reported national statistics [13].

77   Studies in Bangladesh have reported many factors that are associated with the use of facilities for ANC,

78   such as age, religion, parity, having a living child, educational attainment of women, place of residence,

79   household wealth status, decision-making power, complications during the current pregnancy or a

80   previous pregnancy, husband's education, and access to mass media [14, 15]. Similar factors have been

81   identified as determinants of institutional delivery [13, 16, 17].

82   The Government of Bangladesh recommends four focused ANC visits for all low-risk pregnancies based

83   on 2002 WHO recommendations: first ANC visit (within $16+^6$ weeks of gestation), second ANC visit ($24+^0$

84   to $28+^6$ weeks of gestation), third ANC visit (at $32+^6$ weeks of gestation) and fourth ANC visit (at $36+^6$

85   weeks of gestation) [12]. Though utilization of care is increasing, few studies exist on either the

86   utilization or determinants of timely ANC. Also, ~~information on the use of different types of health~~

87   ~~facilities for ANC and delivery care services at the community-level is unavailable.~~ Information on the

88   utilization patterns of public, private, and non-government organization (NGO) health facilities, based on

89   clients' socio-economic and demographic differences, is essential to effectively improve women's care-

90   seeking during pregnancy and childbirth. The present study aims to assess the utilization, timeliness of,

91   and socio-demographic determinants of antenatal and childbirth care services in two sub-districts in

92   Bangladesh.

Methods
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Study design
94

95   This cross-sectional study used data collected as part of a cluster-randomized controlled trial, eRegMat,

96   conducted in two sub-districts, Matlab South and Matlab North under Chandpur district of Bangladesh

97   (trial registration: ISRCTN69491836). Women with pregnancies identified and registered from October

98   2018 to June 2020 were enrolled in the eRegMat trial.

Study setting
99

100   The estimated population of Matlab South and Matlab North sub-districts are approximately 200,000

101   and 300,000, respectively [18]. Matlab South is divided into eight administrative blocks known as

102   unions, while Matlab North has 14 unions. The Ministry of Health and Family Welfare (MOHFW)

103   provides maternal and child health services through two divisions: the Directorate General of Family

104   Planning (DGFP) and the Directorate General of Health Services (DGHS). Under the DGFP, each Union

105   Health & Family Welfare Centre (UH&FWC) serves a population of 25,000. Family welfare visitors (FWV)

106   work at the UH&FWC. Family welfare assistants (FWA) provide community outreach services and are the

107   first contacts of the population at the household level. Under the DGHS, one to four community clinics

108   (CC) provide services in each union, serving about 6000 people each. Community health care providers

109   (CHCP) serve at community clinics (CC), and health assistants (HA) provide care at the household level.

110   Matlab Health and Research Centre, run by the International Centre for Diarrhoeal Disease Research,

111   Bangladesh (icddr,b), and a few non-government organizations (NGOs) also provide maternal and child

112   health care.

113   Since 2018, a digital maternal and child health registry (eRegistry) has been implemented in two sub-

114   districts for use by both CHCP and FWV in health facilities and by HA and FWA for community-level

115   services. The eRegistry is designed so both facility-based and community-based health workers can

116   access an individual's client record and input clinical data. All pregnancies are supposed to be registered

117   in the eRegistry so as to create comprehensive client records. In total, 72 health facilities were included

118   in the eRegistry roll-out, and a cluster-randomized controlled trial (eRegMat) was embedded in the

119   implementation. In health facilities assigned to the intervention group (n=30), three digital health

120   interventions were implemented in addition to the digital longitudinal tracking – clinical decision

121   support, feedback dashboards for health workers, and targeted client communication via SMS to

122   pregnant women. The control group (n=29) facilities used an eRegistry without additional digital health

123   interventions. Pregnancy registrations in a randomized health facility were automatically allocated to

124   their respective intervention or control group, while community registrations received a trial allocation

125   based on the woman's choice of health facility for ANC. Health facilities that were not included in the

126   trial received the eRegistry without digital health interventions to maintain continuity of data and care

127   in the health system and were classified as non-randomized (n=13).

128   For this analysis, we included data on all women in the control and non-randomized groups of the

129   eRegMat trial, as well as women registered in the eRegistry by community-level health workers without

130   trial allocation. Women randomized to the intervention group were excluded in this analysis.

131

Data availability

133   Data were collected from women within eight to fourteen days after childbirth. For a few cases, the data

134   collection period was extended up to nine months, either because women were not available within

135   seven to fourteen days after childbirth or due to the COVID-19 pandemic lockdown measures. Written

136   consent was obtained for the postpartum survey during pregnancy registration in the eRegistry. A

137   structured questionnaire was prepared for the survey; the questionnaire was pretested before data

138   collection began. Data were collected on utilization of ANC and delivery services, birth outcomes, and

139   respondents' socio-economic characteristics. Twenty female data collectors with experience collecting

140   data in household surveys from the same community were recruited and trained for data collection.

141   Two data collectors were appointed to call pregnant women every other week after 28 weeks of

142   gestation and through 35 weeks of gestation and then once a week until their delivery. A monitoring

143   dashboard was developed to identify pregnant women for phone calls based on the gestational age in

144   the eRegistry and collect their pregnancy outcome information. From the monitoring dashboard, one

145   field research assistant produced lists of enrolled women who had a pregnancy outcome daily and

146   distributed those lists to the data collectors. Data collectors then visited the women to conduct the

147   interview after childbirth. After data collection, the survey questionnaires were checked for

148   completeness and discrepancies by the data collectors' supervisors. Data were entered into a web-based

149   electronic form by assigned data entry staff.

Outcome variables

The outcome variables and definitions were as follows: 1) timely first ANC visit: a visit within $17+^6$ weeks of gestation; 2) four timely ANC visits: ANC visits at or before $17+^6$ weeks, $24+^0$ to $28+^6$ weeks, $31+^0$ to $33+^6$ weeks and $35+^0$ to $37+^6$ weeks of gestation according to the national ANC schedule [19]; and 3) facility delivery: a delivery in any health facility, including public, private, and those run by icddr,b and NGOs. To allow for maternal opportunity to attend ANC, we expanded the specific weeks by an additional one-week range, except when the guideline already recommended a range of weeks (for example, $24+^0$ to $28+^6$ weeks), where we kept the original range.

We also analyzed the associations between sociodemographic determinants and Skilled Birth Attendant (SBA) at delivery. SBA at delivery were considered if delivery was conducted by qualified doctor, nurse, midwife, paramedic, family welfare visitor (FWV) or community skilled birth attendant (CSBA) as described in the Bangladesh Health and Demographic Survey [5].

Explanatory Variables

The predictor variables considered in the analysis were age of women, parity, women's education, husband's education, and household wealth index. Parity was defined as the number of times that a woman has given birth to a baby with a gestational age of 28 weeks or more, regardless of whether it was a live birth or stillbirth. Educational status was assessed as the number of completed years of schooling. Household wealth index was calculated by generating scores through principal-components analysis based on household assets of ownership of a number of consumer items (freezer, television, etc.), household livestock, dwelling characteristics (wall and roof material), type of drinking water, toilet facilities, type of fuel mainly used for cooking, and source of electricity. These scores were then indexed into quintiles, where one represented the lowest and five the highest. The last menstrual period date

172 was determined by recall during the interview at the household visit, for consistency. Gestational age at

173 each ANC visit was measured by subtracting the LMP date from the ANC visit date and expressed in

174 weeks and days.

Sample size

176 The total available sample size was 3293 pregnancies. Power calculations were made on the study

177 outcomes. According to the Bangladesh health and demographic survey report and a recent study

178 conducted in Bangladesh we could expect 37% to attend a first timely ANC, 1% to attend four timely

179 ANC visits and 50% of women to have a facility delivery during the study period [5, 20]. To estimate

180 whether our available sample size was sufficient for the detection of prevalence we calculated the

181 power to estimate bounds on the most conservative estimate of 50% of the facility delivery with 4%

182 error probabilities, and an α of .05. The power was estimated at 93%, well above the levels needed, thus

183 our proposed sample size was sufficient to measure the prevalence of timely first ANC, four timely ANC

184 and facility delivery and their association with sociodemographic determinants. We used Stata version

185 16 for the power calculations.

Data analysis

187 We used descriptive statistics to present women's socio-demographic characteristics and the utilization

188 of antenatal and delivery care using percentage distribution, mean, and median. Bivariate analysis was

189 employed to determine the associations between each of the dependent variables and the selected

190 explanatory variables. The level of association was tested by Pearson's chi-square (χ2) tests and

191 statistical significance was considered if the p-value was found to be <0.05. Maternal age was

192 categorized into <20, 20 – 24, 25 – 34, ≥35 years, parity into 0, 1, ≥2, and education into 0– 5, 6 – 10, >

193 10 years of schooling. Quintiles of asset scores were used to categorize socio-economic status.

194   A first ANC visit was considered to be timely if care was received within week $17+^6$ of gestational age.

195   All other first ANC visits were considered not timely. Similarly, the other three routine ANC visits were

196   defined timely if they occurred between week $24+^0$ to $28+^6$, week $31+^0$ to $33+^6$, and week $35+^0$ to $37+^6$.

197   Women were considered to have completed four timely ANC visits if one timely ANC visit was received

198   within each of the four recommended periods of time; all other ANC visits were considered not timely.

199   To determine the associations of socio-demographic variables with timely first ANC, four timely ANC

200   visits, and facility delivery, binary logistic regression was executed. The results of the binary logistic

201   regression analyses were presented by odds ratios (OR) with 95% confidence intervals (CI). All the socio-

202   demographic variables related to the outcomes of interest were included in the multivariate model to

203   adjust for potential confounding. All statistical analyses were done in Stata version 16 [21].

Results

Socio demographic and economics characteristics

206   We included a total of 3293 women in the analysis. Of all the women, 84% were interviewed within 8-14

207   days of childbirth. The characteristics of the women are shown in Table 1. The participants' mean age

208   was 24 years (SD ±4.5); about 18% of women were under the age of 20 years. The median parity was 2,

209   and 40% of participants were nulliparous, while one-fourth of the participants had 2 or more children.

210   The median number of years of school attendance for study participants and their husbands was 9 and 8

211   years, respectively.

ANC Utilization

213   Almost all participants (98%) received at least one ANC visit, while 91% of women received two visits,

214   74% received three visits and half of the participants (52%) received four or more ANC visits. The mean

215 gestational age (GA) at first, second, third and fourth ANC visit was 17.6 weeks (SD ±6.9), 24.3 weeks (SD

216 ±6.8), 28.4 weeks (SD± 5.9) and 31.1 weeks (±4.9) respectively. More than half of the participants (59%)

217 attended a timely first ANC visit and 62%, 42% and 31% of women received timely 2[nd,] 3rd and 4th ANC

218 visits, respectively. Overall, 94% received one ANC visit timely, 68% attended two ANC visits timely and

219 22% utilized three ANC visits timely. But only 4.2% of women attended all four ANC visits according to

220 the recommended ANC schedule.

221 Among the women who attended at least one ANC visit (Fig 1), about 45% attended their first ANC visit

222 in public health facilities, whereas 41% of women visited private facilities. On the other hand, 51% of

223 women received their 4th ANC visit in private facilities, and only 32% in public facilities.

224 **Fig 1. Place of ANC utilization among all women**

225 For ANC visits after the first visit (Fig 2), the public health sector gradually lost more women compared

226 to the private, and icddr,b and NGO health facilities. Of the women who visited a public health facility

227 for their first ANC visit, 56%, 42%, and 26%, used public health facilities for their second, third and

228 fourth ANC visits and 17% for childbirth. Of the women who visited a public health facility for their first

229 ANC visit, 51% of them attended private health facilities for delivery.

230 Of the women (1445) who received their first ANC visit from public facilities, only 6.3% visited public

231 health facilities for all four ANC visits. Among women (1315) who received their first ANC from private

232 facilities, 5.2% received four ANC visits from private facilities. In the case of women (n=398) who

233 received their first ANC visit from icddr,b and NGOs, 3.8% of women went to NGO facilities for all four

234 ANC visits.

235 **Fig 2. Patterns of health facility use for subsequent antenatal and delivery care based on the place of**

236 **the first antenatal care visit.**

237   Most women received their first ANC visit from doctors (Fig 3). Similar trends were seen for the type of

238   healthcare provider for all four ANC visits (Fig 3). Doctors who provided first ANC were mostly (92%)

239   from private facilities, while 89% of nurses and midwives were from NGOs and icddr,b.

240   **Fig 3. ANC utilization by health care providers. CHW (Community Health Workers: FWA, HA, others;**
241   **FWV (Family Welfare Visitor); CHCP (Community Health Care Provider).**
242

Facility delivery

244   Among all respondents (n=3293), 74% of women delivered at a health facility. Of the women who gave

245   birth at a facility, 75% delivered at private facilities, 19% at public health facilities, and 6% at icddr,b, and

246   NGO-led facilities. More than half of the deliveries (54%) were conducted by doctors (Fig 4); 92% of the

247   doctors were from private facilities. About 80% of women used skilled birth attendants (SBA) during

248   childbirth. Of the women who delivered their baby by normal vaginal birth, 41% of them were

249   conducted by a Traditional Birth Attendant (TBA). About half of the participants (51%) delivered their

250   baby by caesarian section and 92% of the cesarean sections occurred in private facilities.

251   **Fig 4. Type of provider performing delivery.**

252

Socio-economic characteristics, and utilization of ANC and facility

delivery

255   During the first ANC visit (Fig 5), 55% of women from the poorest group and 36% from the richest group

256   utilized public facilities, whereas 32% of the poorest group and 49% of the richest group used private

257   health facilities. In the case of icddr,b, and NGO-led facilities, utilization was 10.5% and 13% among the

258   poorest and richest groups, respectively. For the 4th ANC visit and delivery, private health facilities were

259   preferentially utilized by all socio-economic groups (Figs 5 and 6).

260   **Fig 5. Health facility utilization for timely ANC visits by wealth index.**

261

262   **Fig 6. Health facility utilization for facility delivery by wealth index.**

263

264   Socio-economic determinants of timely first ANC visit, four timely ANC visits and facility

265   delivery

266   Women's age, parity, husband's education, and socioeconomic status were associated with a timely first

267   ANC visit (Table 1). Women more than 30 years of age were 1.5 times more likely to attend a timely first

268   ANC visit compared to women less than 20 years of age. Nulliparous women were 1.3 times more likely

269   to attend a timely first ANC visit compared to women with two or more births. Women whose husbands

270   had completed more than ten years of education were 40% more likely to attend a timely first ANC visit

271   than if their husbands had 0-5 years of schooling. Women with higher socioeconomic status were more

272   likely to have a timely first ANC visit. We did not find any associations between the socio-demographic

273   determinants used in our analysis and four timely ANC visits (Table 1).

274   Women's age, parity, women's education, husbands' education, and socio-economic status were

275   associated with facility delivery (Table 1). Women 30 years or older were 1.6 times more likely to deliver

276   in the health facility than women less than 20 years of age. Nulliparous women were 1.5 times more

277   likely to use a health facility for childbirth compared to women with two or more births. Women who

278   completed more than 10 years of school were 97% more likely to use the health facility for childbirth in

279   comparison to women with less than 5 years of education. Women were 53% more likely to have a

280   facility delivery if their husbands completed more than 10 years of school than 0-5 years of education.

281   Women belonging to the highest group of wealth index were 2.2 times more likely to deliver in the

282   health facility. Results with unadjusted odds ratios are presented in a supplementary file (S1 Appendix).

283   Similar associations were found for SBA as for facility delivery (data not shown, in S2 Appendix).

284

285 **Table 1: Associations of timely first ANC visit, timely four ANC visit, and facility delivery with socio-demographic determinants**

Characteristics (n=3293)	N (%)	Timely first ANC visit (n=3242)		Timely four ANC visits (n=3242)		Facility delivery (n=3293)	
		n (%)	Adjusted OR*(95% CI)	n (%)	Adjusted OR* (95% CI)	n (%)	Adjusted OR* (95% CI)
Age in years							
<20	581 (18)	339 (59)	1	20 (5.1)	1	437 (75)	1
20-30	2470 (75)	1433 (59)	1.16 (.93 - 1.45)	103 (6.0)	1.07 (.60 - 1.93)	1826 (74)	1.14 (.88 - 1.48)
>30	242 (7)	148 (63)	1.52 (.96 - 2.19)	13 (7.4)	1.21 (.52 - 2.86)	183 (76)	1.60 (1.05 - 2.43)
Parity							
0	1145 (35)	653 (58)	1.30 (1.04 - 1.62)	47 (6.0)	.68 (.40 - 1.16)	860 (75)	1.52 (1.18 - 1.95)
1	1306 (40)	804 (62)	1.06 (.88 - 1.29)	47 (5.0)	.79 (.50 - 1.25)	1014 (78)	1.38 (1.12- 1.71)
≥ 2	842 (26)	463 (57)	1	42 (7.5)	1	572 (68)	1
Years of education							
0-5	426 (13)	230 (56)	1	12 (4.2)	1	260 (61)	1
6-10	2285 (69)	1302(58)	.94 (.75 - 1.18)	98 (6.3)	1.57 (.83 - 2.97)	1693 (74)	1.38 (1.09 - 1.74)
>10	582 (18)	388 (67)	1.13 (.84 - 1.52)	26 (5.8)	1.46 (.66 - 3.21)	493 (85)	1.97 (1.40 - 2.77)
Husband education							
0-5	888 (27)	464 (54)	1	36 (6.3)	1	577 (65)	1
6-10	1879 (57)	1106 (60)	1.14 (.96 - 1.36)	69 (5.2)	.78 (.51 - 1.21)	1433 (76)	1.31 (1.09 - 1.58)
>10	526 (16)	350(67)	1.40 (1.09 - 1.81)	31 (7.7)	1.25 (.71 - 2.19)	436 (83)	1.53 (1.14 - 2.06)
Assets							
Lowest	671 (20)	336 (52)	1	18 (4.3)	1	422 (63)	1
Second	669 (20)	372 (57)	1.17 (.94 - 1.46)	25 (5.8)	1.40 (.75 - 2.60)	467 (70)	1.23 (.98 - 1.56)
Middle	746 (23)	463 (62)	1.45 (1.17 - 1.81)	35 (6.5)	1.71 (.95- 3.08)	585 (78)	1.84 (1.44 - 2.34)
Fourth	552 (17)	329 (60)	1.27 (1.00 - 1.62)	27 (6.8)	1.74 (.93 -3.26)	428 (78)	1.64 (1.26 - 2.14)
Highest	655 (20)	420 (65)	1.49 (1.18 - 1.89)	31 (6.3)	1.67 (.89 -3.11)	544 (83)	2.15 (1.63 - 2.82)

286 *Adjusted with age, parity, women's education, husband's education, and assets

15

Discussion

288   The study found six in ten women attended a timely first antenatal care visit, but that utilization of four

289   timely ANC visits was very low. Seven in ten women delivered at a health facility. Our study also found

290   that women gradually moved to private hospitals from earlier use of public health facilities, as the

291   pregnancies advanced. The study identified socioeconomic inequities in public versus private health

292   facilities for utilization of ANC and childbirth care. We identified age, parity, wealth index, and education

293   of women's husband as determinants of timely first ANC visit and facility delivery.

294   Utilization of private hospitals for maternal healthcare services is increasing all over the Bangladesh.

295   The unavailability of essential maternal healthcare supplies, services, care providers and the interest of

296   dual practice doctors in the public sector might encourage women to resort to more expensive private

297   sector healthcare [22]. Similar trends were observed in other studies from low- and- middle income

298   countries [23, 24]. Women's negative perceptions and experiences of public health care could also drive

299   them to private health facilities and away from public health facilities [23, 25]. Women and family

300   members' preference to receive care from doctors, especially during the last trimester of pregnancy and

301   for delivery, might drive care-seeking toward private health facilities. Our study ~~confirmed~~ that, of the

302   women receiving care from doctors, the majority were from private hospitals. ~~The Bangladesh~~

303   ~~Demographic and Health Survey (DHS) also reported that a majority of women who used a health facility~~

304   ~~for childbirth delivered at a private clinic~~ [5]. A study conducted in Bangladesh reported increased

305   utilization of private health facilities compared to public health facilities for maternal health care in

306   general [25, 26]. Basic and comprehensive packages of emergency obstetric care with skilled providers,

307   ~~especially doctors~~, may need to routinely be available throughout the public sector to increase retention

308   of women who start their ANC in hopes that they remain there for delivery care.

309 The coverage of a timely first ANC visit in our study is higher than ~~reported in~~ a study conducted in three

310 northern districts of Bangladesh, where 32% of women received a timely first ANC visit from a skilled

311 provider [20]. Our study also shows somewhat higher coverage of a timely first ANC visit compared to

312 the national coverage reported in the most recent DHS (37%) [5]. Another study conducted in

313 Bangladesh measuring initiation of ANC, as a first visit within 12 weeks of gestation, also found low

314 coverage [27]. Implementation of the Maternal Healthcare Voucher program (DSF) in this area by the

315 Ministry of Health and Family Welfare in Bangladesh since 2010, might explain the higher coverage in

316 our study compared to national reports. Several studies have reported low levels of early initiation of

317 ANC in Asia and Africa [28-31], while others have reported higher coverage of an ANC visit within 16

318 weeks [32-34], suggesting wide within- and between-country variations.

319 Although half of women received four or more ANC visits, our study found low coverage of four timely

320 ANC visits illustrating that women might attend adequate numbers of visits, but they lacked actionable

321 information on the nationally recommended ANC visits schedule. The coverage of four timely ANC visits

322 was found to be low despite the higher utilization of the first timely ANC. A possible explanation could

323 be women visited the public health facility for their first ANC as the health facility was very close to their

324 house. ~~They were not oriented then about the availability of services.~~ By the time of the fourth visit,

325 they were often trying to get more essential services such as ultrasonogram which is available in the

326 private facilities. Other studies conducted in northern Bangladesh and Ethiopia found low coverage of

327 four timely ANC visits despite high uptake of the first ANC timely [20, 35]. In Ethiopia, though their first

328 ANC coverage is less than ours, their timely four ANC utilization was notably greater than found in this

329 study. This illustrates that the drivers of timely first ANC and timely four ANC visits may differ within

330 countries and may differ between countries as well. More information is needed to understand these

331 differences. We need to assess the context-specific mechanisms to increase the four timely ANC

332   utilization. Use reminders by phone call or text message could be employed to increase the timeliness of

333   ANC attendance[36-38].

334   Our results provide additional supportive evidence that institutional delivery (74%) is still increasing,

335   including in this particular area. A survey conducted in 2015 in our study area reported a coverage of

336   49% [39]. The higher coverage in our results may be attributed to the implementation of several

337   interventions to increase facility delivery in the study area, including strengthened health education

338   activities by health workers [40]. Demand side financing for ultra-poor women is another such

339   intervention [41, 42]. Other reasons might include increased availability of and access to health facilities

340   as well as overall improvements in the population's economic status [43, 44].

341   Women's husbands' education appears to play a critical role in initiating early ANC and facility delivery.

342   In Bangladesh, men often have the privilege to make decisions for their wives, which may explain the

343   association between husbands' education and maternity service utilization [16, 17, 31, 45]. Our results

344   also show that more educated women were more likely to have an institutional delivery. This may be

345   attributed to the fact that women with higher education have a better understanding of seeking care,

346   more awareness of the value of health care utilization, and making decisions with confidence [16, 28,

347   30, 34, 46-49].

348   This study also found that women's economic status was a crucial predictor of compliance with the

349   nationally recommended first ANC contact and facility delivery, with the richest women more likely to

350   seek early health care. Our results are similar to previous studies that found a positive association

351   between the economic status of women and early initiation of ANC and facility delivery, probably due to

352   ease of access to health care [44, 48, 50]. This study also identified disparities in the use of public and

353   private health facilities for ANC and childbirth care services in Bangladesh's rural context. Poor women

354   used public health facilities more, while rich women were more likely to use private facilities. Designing

18

355   interventions based on inequities in maternal health service utilization is important to increase access to

356   those actually need support.

357   This study has several strengths. Our study is a large, cross-sectional population-based study. Women

358   were interviewed within a short period after birth potentially minimizing the magnitude of the recall

359   bias. Most studies of maternal healthcare utilization and coverage have used survey data, where women

360   with a live birth in the two-three years before the survey were interviewed, which might introduce recall

361   bias. We used a standardized questionnaire to ensure comparable responses from the participants. We

362   used an asset-based index, which is a good proxy for measuring household wealth status. One of the

363   limitations of the study lies in the accurate assessment of gestational age at the ANC visit. Women's

364   recall of the dates of ANC visits could be incomplete or faulty when such data are collected

365   retrospectively through household surveys [51]. This was available for a subset of women through the

366   eRegistry, but we chose to use the data from recall for consistency. Unmeasured predisposing, enabling,

367   and need-based factors not included in our analysis might affect coverage of timely first ANC, timely

368   four ANC visits, and facility delivery. Coverage of four timely visits was low, which precluded meaningful

369   analysis of associations.

370   The study was conducted to assess in detail patterns of health facility utilization in Matlab. Our evidence

371   suggested that women might shift frequently between public and private health system, possibly to get

372   better quality of care. Continuity of care helps to improve the quality of care by establishing good

373   relationships and trust between the provider and women. [52, 53]. A comprehensive description of

374   women's' transition between facilities and types of facilities is critical background to understanding

375   women's decision-making processes and reasoning and is necessary to design appropriate health care

376   interventions to improve care seeking quantity, continuity and timeliness. Further exploration is

377   required to explain their choices and to attempt to encourage continuity of information during

378   pregnancy and delivery. Remaining within a single health system is likely to improve the probability of

379   increased timeliness of ANC utilization.

380   Maternal health care programs should prioritize women with less educated husbands, low socio-

381   economic condition, young age, and multiparity to increase the timely health service utilization and

382   promote good health. Further exploration is required to understand the drivers and needs of these

383   women to increase timely health care utilization. Innovative interventions appropriate for the local

384   settings to address these gaps and increase timely maternal service utilization are crucial.

385   # Abbreviations

386   **ANC:** Antenatal care; **AOR:** Adjusted Odds Ratio; **eRegMat**: electronic registry Matlab; **DHIS2:** District

387   Health Information System 2; **CC**: Community Clinic; **UH&FWC:** Union Health and Family Welfare

388   Centres; **MOHFW:** Ministry of Health and Family Welfare; **DGFP**: Directorate General of Family Planning;

389   **DGHS**: Directorate General of Health Services; **FWV:** Family Welfare Visitor; **FWA:** Family Welfare

390   Assistant; **CHCP:** Community Health Care Provider; **HA:** Health Assistant; **NGO:** Non-government

391   organization; **icddr,b :** International Centre for Diarrheal Disease, Bangladesh

392   # Declarations

393   # Ethics approval and consent to participate

394   The study was approved by the Research and Ethical Review Committees of the International Centre for

395   Diarrhoeal Disease Research, Bangladesh, and the Regional Ethical Committee in Norway, Southeast

396   region. All participants received an explanation of the purpose of the study and gave written informed

397   consent for participation in the study.

Consent for publication

Not applicable.

Availability of data and materials

All relevant data are available within the manuscript and its supporting Information file.

Funding

Authors' contributions

JFF, AR, IKF, JP, and MV contributed to the study concept and design. AR, IKF and JP supervised the implementation of the study. JP, UTN, and MR were involved in data collection and JP, MV, UTN, MR, BO, IKF, AR, and JFF contributed to data analyses. JP drafted the initial draft of the manuscript. JP, MV, UTN, MR, BO, IKF, AR, and JFF, reviewed and approved the final version of the manuscript.

Competing interests

The authors declare that they have no competing interests.

Acknowledgements

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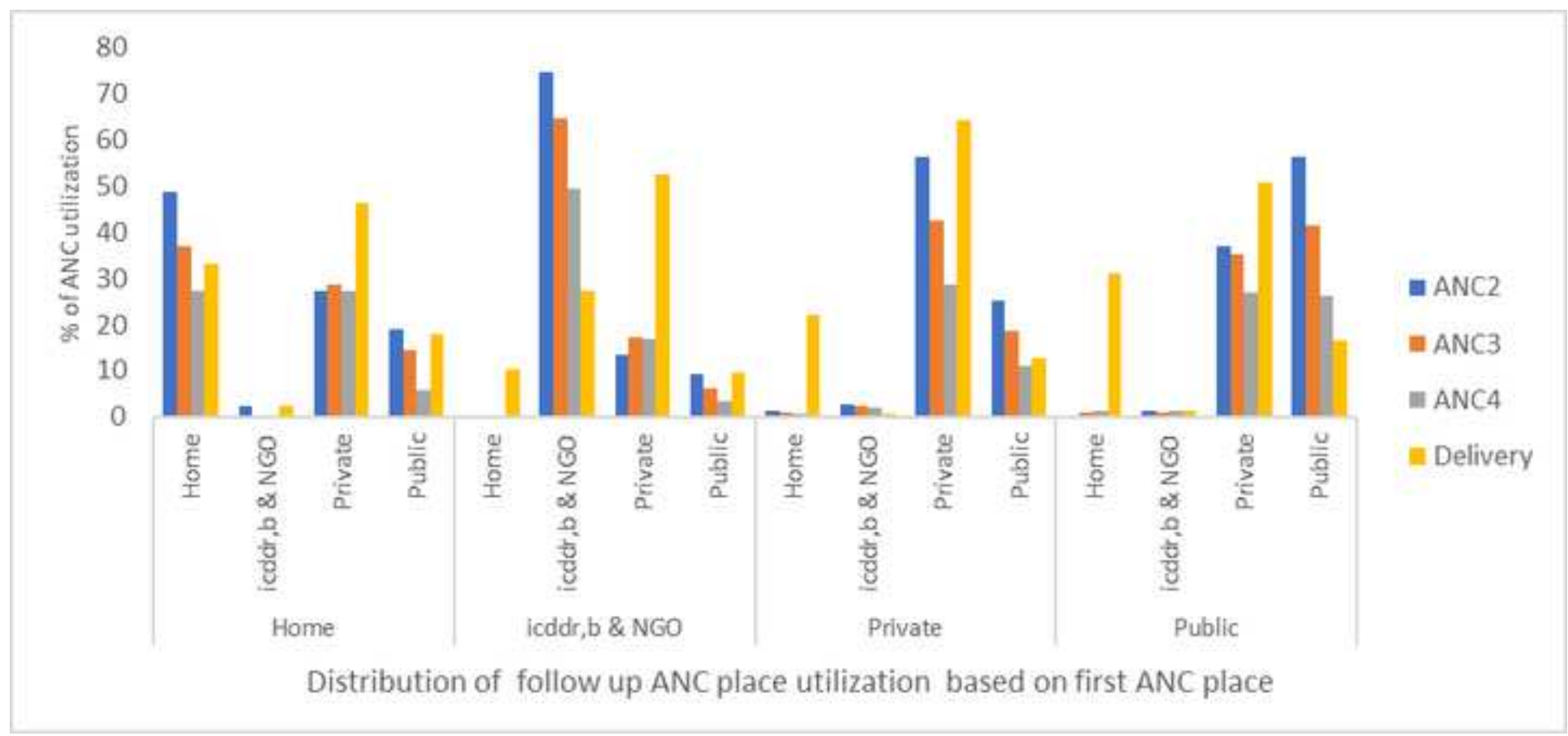
548

Supporting Information

550 **S1 Appendix. Associations of socio-economic characteristics and outcome variables -unadjusted odds**
551 **ratios.**
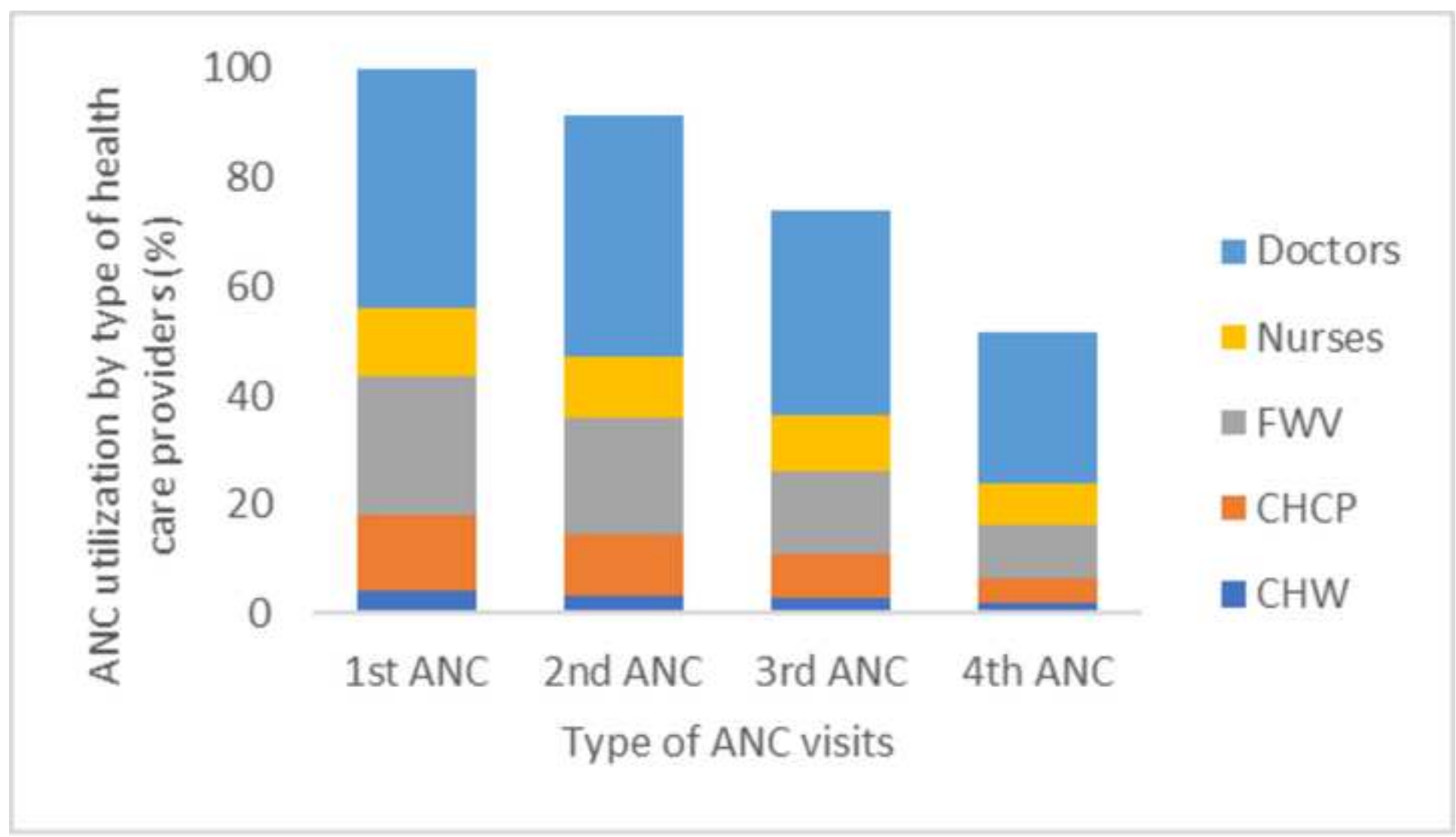
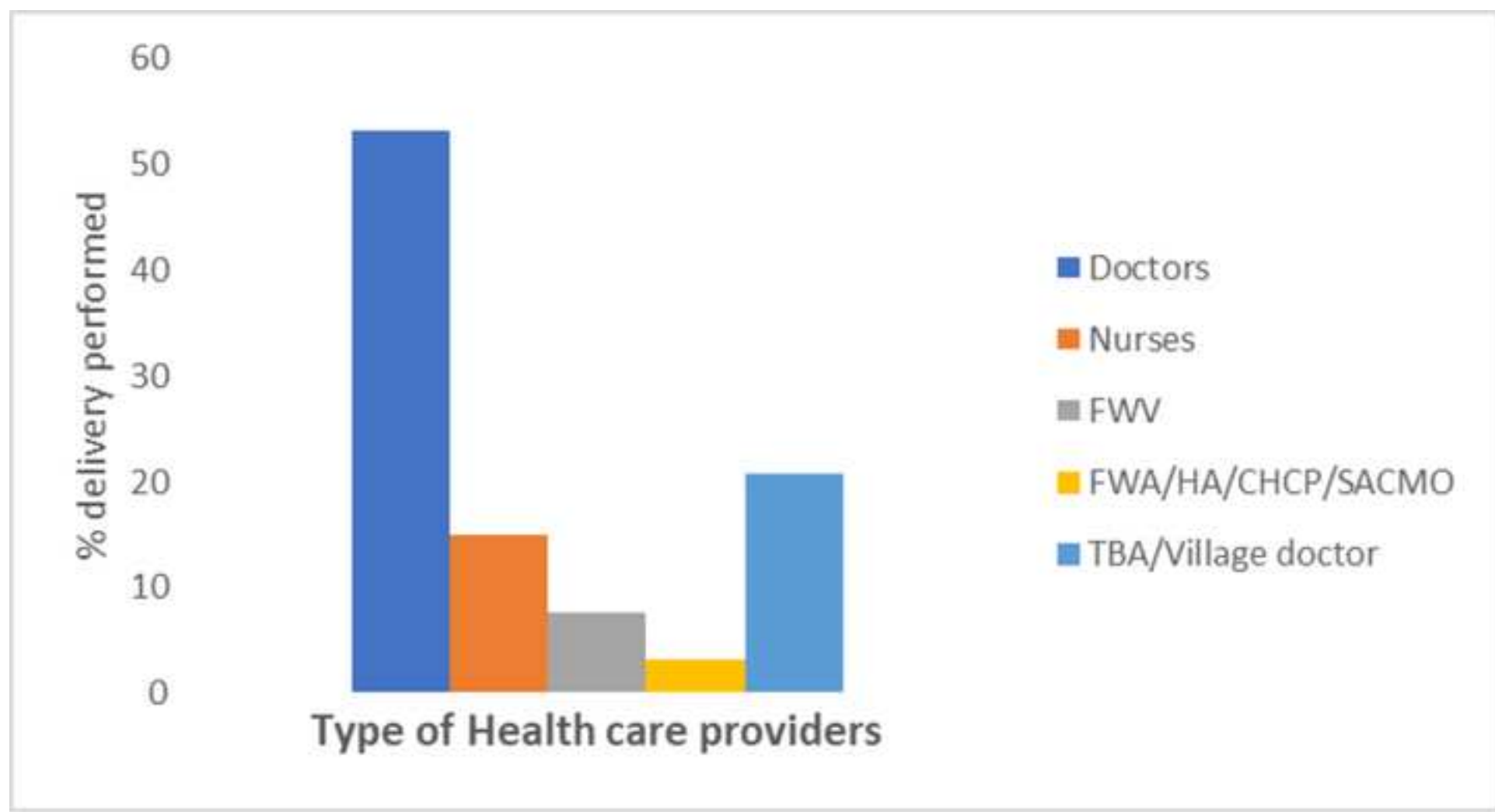552 **S2 Appendix. Associations of Skilled Birth attendance at delivery with socio-economic determinants.**
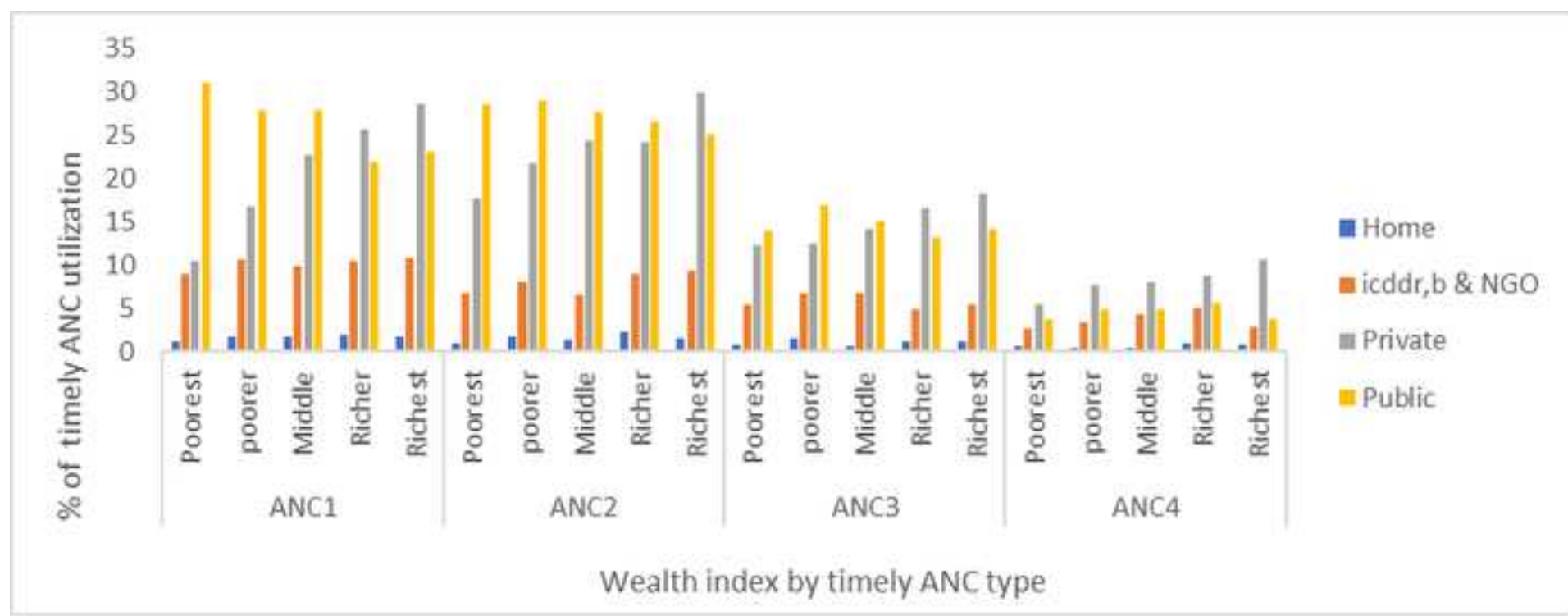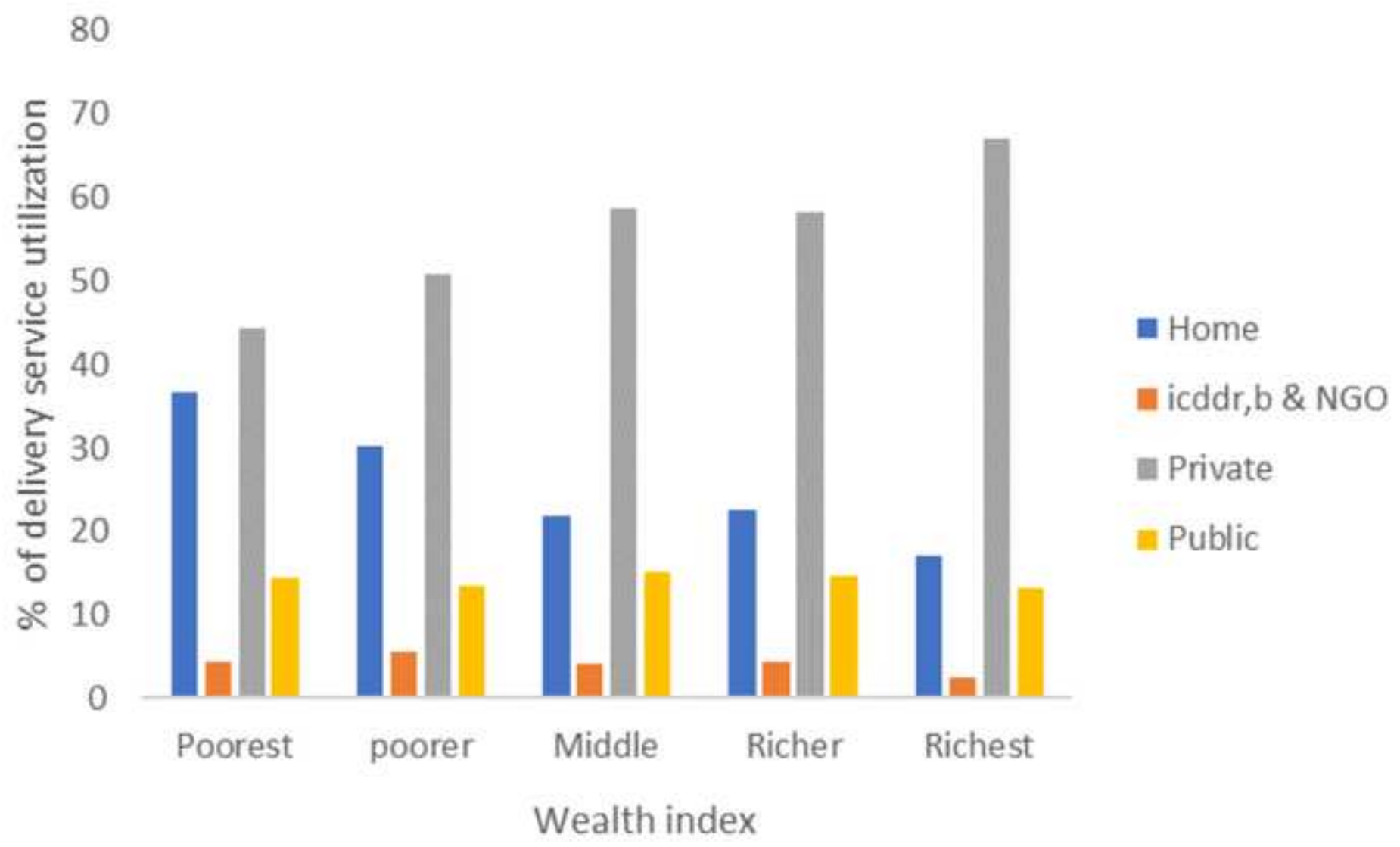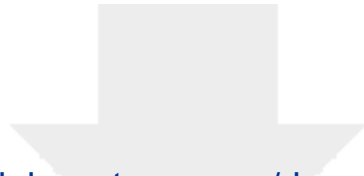
553 **S1 Dataset.**

554 **S1 Questionnaire.**

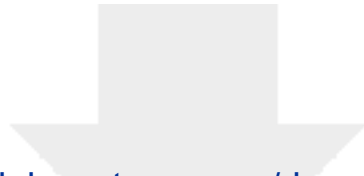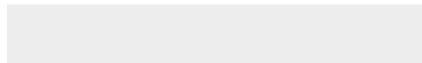Distribution of follow up ANC place utilization based on first ANC place
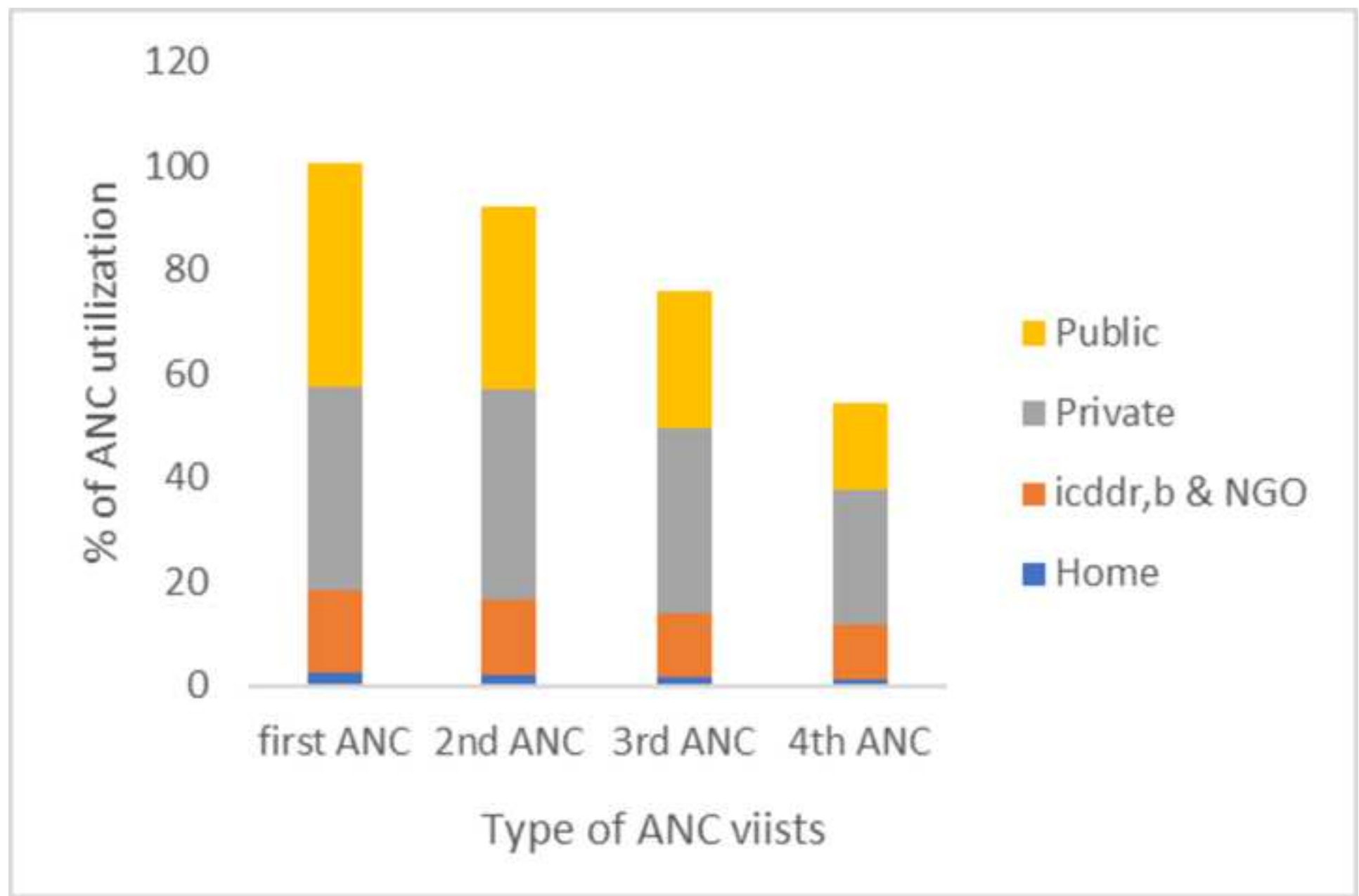
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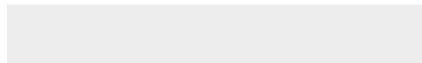
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