

Effects of maternal utilization of continuum of care on complementary feeding practices in Bangladesh: unveiling bottlenecks and opportunities

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Table of Contents

Original Manuscript.....	4
Supplementary Files.....	22
Related publication(s) - for reviewers eyes onlies	23
Related publication(s) - for reviewers eyes only 0.....	23

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Effects of maternal utilization of continuum of care on complementary feeding practices in Bangladesh: unveiling bottlenecks and opportunities

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Abstract

Background: Continuum of Care (CoC) for maternal health — combining Antenatal Care (ANC), delivery assisted by Skilled Birth Attendants (SBA), and Postnatal Care (PNC) — are platforms to deliver messages and counseling on child feeding practices.

Objective: We aim to examine the effect of maternal utilization of CoC on complementary feeding practices in Bangladesh.

Methods: Bangladesh Demographic and Health Survey (BDHS) 2017-18 and BDHS 2022 data were utilized. Observations corresponding to CoC and complementary feeding indicators, i.e. timely Introduction to Solid, Semi-solid, and Soft Foods (ISSSF), Minimum Meal Frequency (MMF), Minimum Dietary Diversity (MDD), and Minimum Acceptable Diet (MAD) were merged to prepare analyzed samples. The differences in complementary feeding practices by maternal utilization of CoC were observed using chi-squared tests. Multivariable logistic regression models were used to observe the associations.

Results: A total of 887, 4967, 4967, and 4967 mother-child pairs were included in the analysis for timely ISSSF, MMF, MDD and MAD, respectively. Mothers who received full CoC were 29% and 32% more likely to provide MDD (AOR: 1.29, 95% CI: 1.10, 1.51, $p = 0.002$) and MAD (AOR: 1.32, 95% CI: 1.13, 1.55, $p = 0.001$) than those of their counterparts, respectively. No significant effect of maternal utilization of CoC was observed on timely ISSSF and MMF.

Conclusions: Maternal utilization of CoC appears to be efficacious in improving MDD and MAD, further highlighting the scopes to amplify the benefits of CoC on timely ISSSF and MMF.

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Original Manuscript

Effects of maternal utilization of continuum of care on complementary feeding practices in Bangladesh

Abstract

Objectives

Continuum of Care (CoC) for maternal health — combining Antenatal Care (ANC), delivery assisted by Skilled Birth Attendants (SBA), and Postnatal Care (PNC) — are platforms to deliver messages and counseling on child feeding practices. We aim to examine the effect of maternal utilization of CoC on complementary feeding practices in Bangladesh.

Methods

Bangladesh Demographic and Health Survey (BDHS) 2017-18 and BDHS 2022 data were utilized. Observations corresponding to CoC and complementary feeding indicators, such as timely Introduction to Solid, Semi-solid, and Soft Foods (ISSSF), Minimum Meal Frequency (MMF), Minimum Dietary Diversity (MDD), and Minimum Acceptable Diet (MAD) were merged to prepare analyzed samples. The differences in complementary feeding practices by maternal utilization of CoC were observed using chi-squared tests. Multivariable logistic regression models were used to observe the associations.

Results

A total of 887, 4967, 4967, and 4967 mother-child pairs were included in the analysis for timely ISSSF, MMF, MDD and MAD, respectively. Mothers who received full CoC were 29% and 32% more likely to provide MDD (AOR: 1.29, 95% CI: 1.10, 1.51, $p=0.002$) and MAD (AOR: 1.32, 95% CI: 1.13, 1.55, $p=0.001$) than those of their counterparts, respectively. No significant effect of maternal utilization of CoC was observed on timely ISSSF and MMF.

Conclusion

Maternal utilization of CoC appears to be efficacious in improving MDD and MAD, further highlighting the scopes to amplify the benefits of CoC on timely ISSSF and MMF.

Keywords

ANC; PNC; Complementary Feeding; Dietary Diversity; Minimum Acceptable Diet; Bangladesh; BDHS

Introduction

The age of 6-23 months shares the largest proportion of the first 1000 days of life, which is called the critical window of opportunity (1). This age group is characterized by rapid body growth, cognitive development, language acquisition, personality development, and outstanding learning

skills (1,2). Therefore, children 6-23 months of age critically require proper nutrition, which is primarily met by appropriate complementary feeding, which demonstrates a significant association with childhood growth (3,4). As the infants grow up, their requirement for essential micronutrients increases, which is not fulfilled by breast milk alone, requiring quality and frequency of complementary food. Evidence shows that proper complementary feeding can help maintain adequate iron and zinc status and protect young children from iron and zinc deficiencies (5). Children aged 6-23 months are highly vulnerable to malnutrition; therefore, poor complementary feeding can result in growth faltering, which might be irreversible in later life (6). Apart from undernutrition, the period of complementary feeding is a crucial opportunity to prevent overweight and obesity during adulthood (7).

Initiation of complementary feeding at 6 months of age triggers the transition from breastfeeding to family foods; however, the process should take several factors into careful consideration, including children's growth patterns, requirements of essential nutrients, appetite, satiety, and quality of food (8). The frequency, quantity, and quality of complementary food differ by children's age, so the provision of age-appropriate complementary feeding requires caregivers skilled or educated in complementary feeding practices. One of the most considered strategies to improve caregivers' complementary feeding practices is to provide them with knowledge and motivation, especially through interventions during antenatal and postnatal periods, which are often integrated with antenatal care (ANC) and postnatal care (PNC).

CoC for maternal health offers a package of healthcare services, from pregnancy to the postnatal period, which are essential for survival and well-being for mother and newborn. These services include at least 4 ANC visits by skilled care providers during pregnancy, delivery assisted by Skilled Birth Attendants (SBA), and a PNC within 48 hours of delivery. These services provide pregnant mothers with opportunities to be in contact with trained healthcare providers during critical periods. Therefore, ANC and PNC are platforms to deliver nutrition education and sensitize mothers on childcare and complementary feeding. Furthermore, having delivery by SBA indicates mothers' positive healthcare-seeking behavior, which may be carried forward to practice recommended complementary feeding. Evidence shows interventions to improve complementary feeding practice target pregnant mothers, considering ANC as a valuable platform to provide counseling and education (9–11). In low- and middle-income countries, nutrition education and complementary feeding interventions appeared to exhibit significant positive results on linear growth among children (4,12).

Despite invaluable benefits, complementary feeding practice in Bangladesh demonstrates a frustrating picture, with only 20% of children 6-23 months of age receiving a minimum acceptable diet in 2024 (13,14). According to the latest demographic and health survey in 2022, only 30% children were fed with a minimum acceptable diet, and this unfortunately experienced a drop from 35% in 2017 (15,16). Addressing malnutrition and micronutrient deficiencies through the promotion of complementary feeding practice is one of the key priorities in the second national plan of action of nutrition in Bangladesh (17). One of the strategies to achieve nutrition goals is mainstreaming nutrition, where many nutrition services are integrated into health services such as ANC and PNC, hypothesizing that mothers who undergo maternal healthcare services exhibit better performance in child feeding practices (17,18). However, no previous study investigated the effect of maternal utilization of CoC on complementary feeding practices in Bangladesh. Utilizing two national representative surveys, the current study aims to fill this research gap. The findings might help policymakers to understand how the benefits of maternal utilization of CoC translate to complementary feeding practices, with identifying priorities and way forwards.

Methods

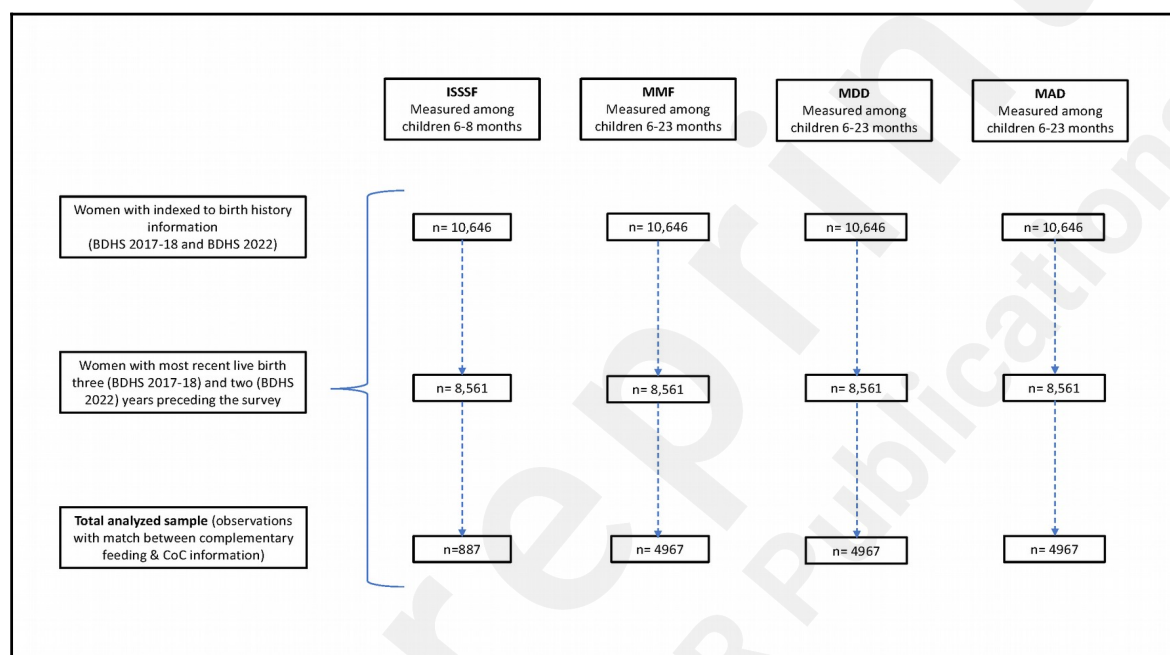
Study design and samples

This study utilized two nationally representative cross-sectional surveys as data sources. These sources are the Bangladesh Demographic and Health Survey (BDHS) of 2017-18 and BDHS 2022. The surveys applied two-stage stratified cluster random sampling and obtained a response rate of more than 98%. The detailed methods are outlined elsewhere (15,16).

However, in brief, the study only analyzed samples with complete information about maternal utilization of CoC and coupled with respective complementary feeding indicators, *i.e.* Introduction to Solid, Semi-solid and Soft food (ISSSF), Minimum Meal Frequency (MMF), Minimum Dietary Diversity (MDD), and Minimum Acceptable Diet (MAD). Therefore, from the dataset, women indexed to birth history information were filtered. Then, women who had a live birth within the last three and two years prior to the surveys, respectively for BDHS 2017-18 and BDHS 2022, were retrieved. These retrieved observations served as the source datasets to estimate the maternal utilization of CoC or exposure variables. Finally, the maternal CoC variables were merged with variables accommodating respective complementary feeding, making the analyzed samples for respective complementary feeding indicators. [Figure 1](#) demonstrates the sample selection process.

Fig 1: Selection process of the analyzed sample

Fig 1 note: BDHS (Bangladesh Demographic and Health Survey); ISSSF (Introduction to Solid, Semi-solid and Soft Food); MAD (Minimum Acceptable Diet); MMF (Minimum Meal Frequency); MDD (Minimum Dietary Diversity)

Exposure variables

The exposure variables are the maternal utilization of CoC and its three components. The components include 1) at least four ANC visits by skilled healthcare providers during pregnancy, 2) SBA assisted delivery, and 3) at least one PNC visits by skilled healthcare providers within 48 hours of delivery. In the present instance, the skilled healthcare providers are denoted as doctors, nurses, midwives or paramedics, family welfare visitors, community skilled birth attendants, and sub-assistant community medical officers. Mothers were coded as 1 if they received all three components of CoC, otherwise 0. Similarly, mothers who utilized any individual component of CoC were coded 1, otherwise 0, and analyzed separately.

Outcome variables

The outcome variables include complementary feeding indicators, e.g., ISSSF, MMF, MDD, and MAD. The status of ISSSF was estimated by calculating the proportion of children 6-8 months of age who were fed solid, semi-solid, or soft food during the previous day or night. MMF refers to the minimum number of meals to be provided among children 6-23 months by their age category (6-

8 months and 9-23 months) and breastfeeding status (breastfed and non-breastfed). Furthermore, MDD indicates the minimum number of food groups to be provided among children 6-23 months. Finally, the estimation of MAD considers both MMF and MDD, indicating that a child had MAD if both MMF and MDD were met. Calculation of the outcome variables was based on Demographic and Health Survey (DHS) guidelines (19,20). Positive status of ISSSF, MMF, MDD, and MAD was coded as 1, otherwise 0.

Covariates

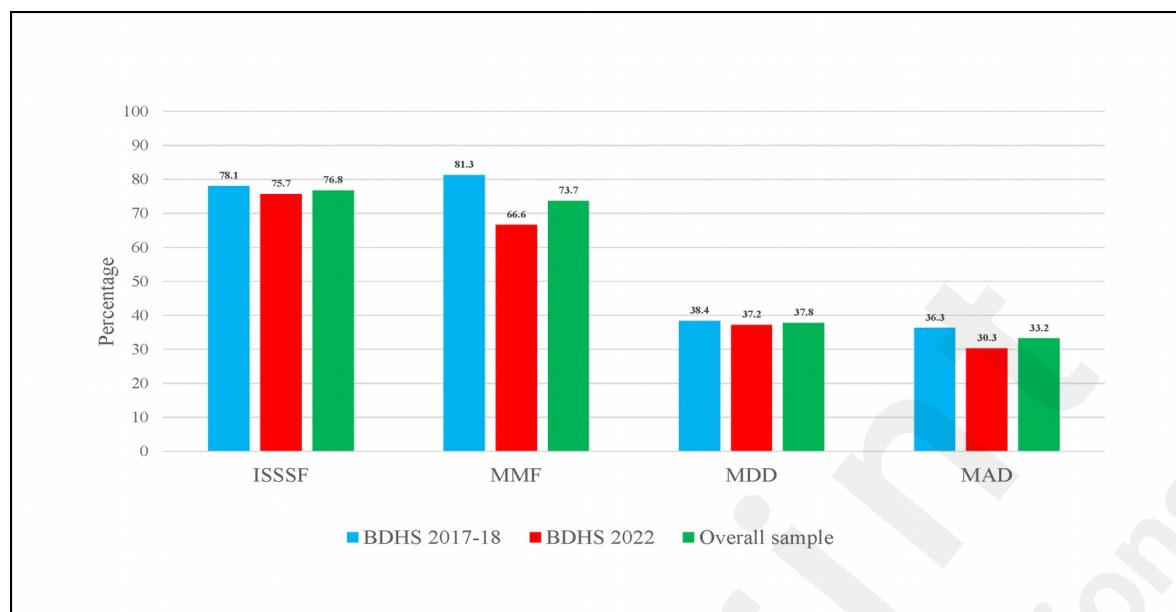
Covariates were selected based on their expected association with exposure variables and evidence from published literature (21–23). Therefore, covariates considered are: age at delivery (< 19 years, 19-30 years, 31-49 years), education level (no education, primary, secondary, and higher), husband's education level (no education, primary, secondary, and higher), occupation (not working, working), husband's occupation (not working, working), parity (1, 2-3, > 3), ever terminated pregnancy (never/no, ever/yes), desired pregnancy (yes, no), wealth index (poorest, poorer, middle, richer, richest), any exposure to television, radio, or news (yes, no), facing problems such as getting permission and money and long distance to access healthcare (big problem, not a big problem), religion (Muslim, other), place of residence (rural, urban), division of residence (Barisal, Chittagong, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, Sylhet), and survey round (BDHS 2017-18, BDHS 2022).

Statistical analysis

Cross tabulation was used to observe the distribution of complementary feeding status by maternal utilization of CoC and covariates, and the differences were observed using chi-squared tests. The binary nature of outcome variables led to the consideration of univariable and multivariable logistic regression models to estimate the effect of maternal utilization of CoC, further delineated as its individual components, on complementary feeding practices among children 6-23 months. Therefore, the individual effect of maternal utilization of full CoC, receiving ≥ 4 ANC, delivery assisted by SBA, and having PNC within 48 hours of delivery on four complementary feeding indicators was observed, resulting in a total of 16 multivariable logistic regression models to observe the associations. The logistic regression models were adjusted for sampling weight, strata, and primary sampling unit, and covariates by using the “svy” command. Multicollinearity was observed by the Standard Error (SE) of the odds ratio and Variance Inflation Factor (VIF), considering $SE > 2$ or $VIF > 5$ as indicators of the presence of multicollinearity (24,25). All the analyses were conducted considering $p < 0.05$ as statistically significant. STATA software version 17 (StataCorp, College Station, Texas, USA) was used to conduct statistical analysis.

Ethical considerations

The demographic and health survey (DHS) was approved by the ICF Macro Institutional



Review
Board
(USA),
following
the
overall

requirements of 45 CFR 46 ‘Protection of Human Subjects’. Moreover, as the data collection procedure was carried out in Bangladesh, the National Research Ethics Committee of the Bangladesh Medical Research Council (BMRC), Dhaka, Bangladesh, also reviewed and approved the BDHS. Before enrollment in the study, informed consent was taken verbally from each participant and their intimate partners (all ever-married women aged 15–49 years). Verbal consent was considered the most suitable option to reassure the participation of respondents who were incapable of reading. Very young children who were under 5 years either born in 2014 or later, were also considered in the sample when the data collection procedure was conducted by the BDHS, so that the mothers of the children were approached for providing verbal consent on behalf of their children.

Results

A total of 8,561 observations were included in the analysis (ISSSF = 887, MMF = 4967, MDD = 4967, MAD = 4967). The status of timely ISSSF, MMF, MDD, and MAD is portrayed in Fig 2.

Fig 2: Status of complementary feeding practices in Bangladesh

Fig 2 note: BDHS (Bangladesh Demographic and Health Survey); ISSSF (Introduction to Solid, Semi-solid and Soft Food); MAD (Minimum Acceptable Diet); MMF (Minimum Meal Frequency); MDD (Minimum Dietary Diversity)

The distribution of outcome variables by maternal utilization of CoC, ANC, delivery assisted by SBA, PNC, and maternal socioeconomic characteristics is presented in Table 1. The analysis shows that the distributions of all four outcome variables were statistically significantly ($p < 0.05$) differed by maternal utilization of CoC, ≥ 4 ANC, PNC within 48 hours of birth, maternal education, husband's education, maternal occupation, wealth index, perceived problems while accessing healthcare, and division. Additionally, the status of MMF, MDD, and MAD significantly differed by maternal status of media exposure and place of residence, while delivery assisted by SBA, husband's occupation, and parity were variables to show significant difference in the distribution of MDD and MAD.

Table 1: Distribution of complementary feeding indicators by status of maternal utilization of CoC and background characteristics.

Independent variables	ISSSF			MMF			MDD			MAD		
	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
CoC												
No	145 (23.89)	462 (76.11)	0.001	987 (28.41)	2487 (71.59)	< 0.001	2319 (66.75)	1155 (33.25)	< 0.001	2483 (71.47)	991 (28.53)	< 0.001
Yes	39 (13.93)	241 (86.07)		290 (19.42)	1203 (80.58)		746 (49.97)	747 (50.03)		811 (54.32)	682 (45.68)	
≥ 4 ANC												
No	114 (23.80)	365 (76.20)	0.015	827 (29.96)	1933 (70.04)	< 0.001	1892 (68.55)	868 (31.45)	< 0.001	2017 (73.08)	743 (26.92)	< 0.001
Yes	70 (17.16)	338 (82.84)		450 (20.39)	1757 (79.61)		1173 (53.15)	1034 (46.85)		1277 (57.86)	930 (42.14)	
Delivery by SBA												
No	76 (23.97)	241 (76.03)	0.077	513 (26.96)	1390 (73.04)	0.113	1302 (68.42)	601 (31.58)	< 0.001	1368 (71.89)	535 (28.11)	< 0.001
Yes	108 (18.95)	462 (81.05)		764 (24.93)	2300 (75.07)		1763 (57.54)	1301 (42.46)		1926 (62.32)	1138 (37.14)	
PNC within 48 hours												

Independent variables	ISSSF			MMF			MDD			MAD		
	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
No	99 (25.38)	291 (74.62)	0.003	675 (28.98)	1654 (71.02)	< 0.001	1561 (67.02)	768 (32.98)	< 0.001	1675 (71.92)	654 (28.08)	< 0.001
Yes	85 (17.10)	412 (82.90)		602 (22.82)	2036 (77.18)		1504 (57.01)	1134 (42.99)		1619 (61.37)	1019 (38.63)	
Age at delivery												
<19 years	20 (17.70)	93 (82.30)	0.390	177 (24.05)	559 (75.95)	0.094	448 (60.87)	288 (39.13)	0.737	482 (65.49)	254 (34.51)	0.467
19-30 years	138 (21.94)	491 (78.06)		917 (26.60)	2531 (73.40)		2140 (62.06)	1308 (37.94)		2305 (66.84)	1143 (33.15)	
31-49 years	26 (17.93)	119 (82.07)		183 (23.37)	600 (76.63)		477 (60.92)	306 (39.08)		507 (64.75)	276 (35.25)	
Education level												
No education	12 (26.09)	34 (73.91)	0.031	90 (32.85)	184 (67.15)	< 0.001	217 (79.20)	57 (20.80)	< 0.001	227 (82.85)	47 (17.15)	< 0.001
Primary	48 (23.41)	157 (76.59)		338 (27.06)	911 (72.94)		903 (72.30)	346 (27.70)		936 (74.94)	313 (25.06)	
Secondary	104 (21.89)	371 (78.11)		659 (26.31)	1846 (73.69)		1528 (61.00)	977 (39.00)		1657 (66.15)	848 (33.85)	
Higher	20 (12.42)	141 (87.58)		190 (20.23)	749 (79.77)		417 (44.41)	522 (55.59)		474 (50.48)	465 (49.52)	
Husband's education												
No education	30 (22.56)	103 (77.44)	0.047	230 (32.72)	473 (67.28)	< 0.001	523 (74.40)	180 (25.60)	< 0.001	553 (78.66)	150 (21.34)	< 0.001
Primary	66 (23.66)	213 (76.34)		412 (25.99)	1173 (74.01)		1070 (67.51)	515 (32.49)		1116 (70.41)	469 (29.59)	
Secondary	66 (21.57)	240 (78.43)		426 (26.30)	1194 (73.70)		989 (61.05)	631 (38.95)		1081 (66.73)	539 (33.27)	
Higher	21 (12.88)	142 (87.12)		189 (18.94)	809 (81.06)		444 (44.49)	554 (55.51)		500 (50.10)	498 (49.90)	
Occupation status												
Not working	144 (23.19)	477 (76.81)	0.007	978 (28.83)	2414 (71.17)	< 0.001	2130 (62.79)	1262 (37.21)	0.020	2310 (68.10)	1082 (31.90)	< 0.001
Working	40 (15.09)	225 (84.91)		299 (19.00)	1275 (81.00)		934 (59.34)	640 (40.66)		983 (62.45)	591 (37.55)	
Husband's occupation												
Not working	4 (23.53)	13 (76.47)	0.777	32 (32.32)	67 (67.68)	0.125	71 (71.72)	28 (28.28)	0.039	77 (77.78)	22 (22.22)	0.015
Working	180 (20.71)	689 (79.29)		1236 (25.52)	3608 (74.48)		2980 (61.52)	1864 (38.48)		3200 (66.06)	1644 (33.94)	
Paternity												
Not	57 (17.59)	267 (82.41)	0.130	445 (23.87)	1419 (76.13)	0.069	1067 (57.24)	797 (42.76)	< 0.001	1172 (62.88)	692 (37.12)	< 0.001

Independent variables	ISSSF			MMF			MDD			MAD		
	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
2-3	101 (21.77)	363 (78.23)		694 (26.91)	1885 (73.09)		1628 (63.13)	951 (36.87)		1740 (67.7)	839 (32.53)	
> 3	26 (26.26)	73 (73.74)		138 (26.34)	386 (73.66)		370 (70.61)	154 (29.39)		382 (72.90)	142 (27.10)	
Ever terminated pregnancy												
No	154 (21.15)	574 (78.85)	0.520	1069 (26.11)	3025 (73.89)	0.161	2542 (62.09)	1552 (37.91)	0.228	2731 (66.71)	1363 (33.29)	0.208
Yes	30 (18.87)	129 (81.13)		208 (23.83)	665 (76.17)		523 (59.91)	350 (40.09)		563 (64.49)	310 (35.51)	
Desire pregnancy												
Yes	143 (20.43)	557 (79.57)	0.654	1026 (26.09)	2907 (73.91)	0.235	2423 (61.61)	1510 (38.39)	0.777	2614 (66.56)	1319 (33.54)	0.672
No	41 (21.93)	146 (78.07)		251 (24.27)	783 (75.73)		642 (62.09)	392 (37.91)		680 (65.76)	354 (34.24)	
Health index												
Poorest	51 (27.27)	136 (72.73)	0.030	328 (30.14)	737 (69.86)	< 0.001	780 (73.93)	275 (26.07)	< 0.001	817 (77.44)	238 (22.56)	< 0.001
Poorer	36 (20.22)	142 (79.78)		285 (27.51)	751 (72.49)		684 (66.02)	352 (33.98)		726 (70.08)	310 (29.92)	
Middle	31 (16.85)	153 (83.15)		235 (25.54)	685 (74.46)		592 (64.35)	328 (35.65)		630 (68.48)	290 (31.52)	
Richer	43 (23.50)	140 (76.50)		244 (24.67)	745 (75.33)		580 (58.65)	409 (41.35)		632 (63.90)	357 (36.10)	
Richest	23 (14.84)	132 (85.16)		195 (20.17)	772 (79.83)		429 (44.36)	538 (55.64)		489 (50.57)	478 (49.43)	
Media exposure ^a												
No	87 (23.20)	288 (76.80)	0.123	620 (31.38)	1356 (68.62)	< 0.001	1391 (70.39)	585 (29.61)	< 0.001	1487 (75.25)	489 (24.75)	< 0.001
Yes	97 (18.95)	415 (81.05)		657 (21.97)	2334 (78.03)		1674 (55.97)	1317 (44.03)		1807 (60.41)	1184 (39.59)	
Excessing healthcare ^b												
Not a big problem	61 (16.27)	314 (83.73)	0.005	434 (21.35)	1599 (78.65)	< 0.001	1175 (57.80)	858 (42.20)	< 0.001	1265 (62.22)	768 (37.78)	< 0.001
Big problem	123 (24.02)	389 (75.98)		843 (28.73)	2091 (71.27)		1890 (64.42)	1044 (35.58)		2029 (69.15)	905 (30.85)	
Religion												
Muslim	168 (20.77)	641 (79.23)	0.958	1191 (26.00)	3389 (74.00)	0.102	2833 (61.86)	1747 (38.14)	0.459	3043 (66.44)	1537 (33.56)	0.527
Others	16 (20.51)	62 (79.49)		86 (22.22)	301 (77.78)		232 (59.95)	155 (40.05)		251 (64.86)	136 (35.14)	
Residence												
Urban	46 (17.10)	223 (82.90)	0.077	368 (22.63)	1258 (77.37)	0.001	909 (55.90)	717 (44.10)	< 0.001	990 (60.89)	636 (39.11)	< 0.001

Independent variables	ISSSF			MMF			MDD			MAD		
	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
Rural	138 (22.33)	480 (77.67)		909 (27.21)	2432 (72.79)		2156 (64.53)	1185 (35.47)		2304 (68.96)	1037 (31.04)	
Vision												
Barisal	20 (19.23)	84 (80.77)	< 0.001	168 (31.82)	360 (68.18)	< 0.001	355 (67.23)	173 (32.77)	< 0.001	375 (71.02)	153 (28.98)	< 0.001
Chittagong	49 (36.84)	84 (63.16)		292 (35.57)	529 (64.43)		541 (65.90)	280 (34.10)		588 (71.62)	233 (28.38)	
Dhaka	30 (24.00)	95 (76.00)		170 (23.55)	552 (76.45)		418 (57.89)	304 (42.11)		452 (62.60)	270 (37.40)	
Khulna	7 (7.29)	89 (92.71)		79 (15.11)	444 (84.89)		279 (53.35)	244 (46.65)		297 (56.79)	226 (43.21)	
Mymensingh	14 (12.50)	98 (87.50)		137 (22.03)	485 (77.97)		369 (59.32)	253 (40.68)		401 (64.470)	221 (35.53)	
Rajshahi	13 (15.85)	69 (84.15)		124 (24.60)	380 (75.40)		307 (60.91)	197 (39.09)		328 (65.08)	176 (34.92)	
Rangpur	15 (13.76)	94 (86.24)		117 (19.70)	477 (80.30)		338 (56.90)	256 (43.10)		371 (62.46)	223 (37.54)	
Sylhet	36 (28.57)	90 (71.43)		190 (29.10)	463 (70.90)		458 (70.14)	195 (29.86)		482 (73.81)	171 (26.19)	
Survey round												
BDHS 17	77 (18.73)	334 (81.27)	0.170	426 (17.63)	1991 (82.37)	< 0.001	1476 (61.07)	941 (38.93)	0.366	1526 (63.14)	891 (36.86)	< 0.001
BDHS 22	107 (22.48)	369 (77.52)		851 (33.37)	1699 (66.63)		1589 (62.31)	961 (37.69)		1768 (69.33)	782 (30.67)	

^aMedia exposure: Reading newspapers or watching television or hearing radio; ^bAccessing healthcare: perceived that receiving permission to visit healthcare facilities or not having money to access healthcare, or distance to health facilities are big problems. ISSSF = Introduction to solid, semi-solid, and soft food, MMF = Minimum meal frequency, MDD = Minimum dietary diversity, MAD = Minimum acceptable diet.

The association between complementary feeding practices and maternal utilization of CoC and its components is presented in Table 2. The analysis shows neither maternal utilization of CoC nor its components had any significant association with the timely introduction of solid, semi-solid, and soft foods among children 6-8 months. On the other hand, MDD, and MAD among children 6-23 months of age were statistically significantly associated with maternal utilization of CoC and receiving ≥ 4 ANC.

Mothers who received full CoC were 29%, and 32% higher likelihood of providing MDD (AOR: 1.29; 95% CI: 1.10, 1.51; $p = 0.002$), and MAD (AOR: 1.32; 95% CI: 1.13, 1.55; $p < 0.001$) to their children, respectively, than that of their counterparts. Likewise, maternal status of receiving ≥ 4 ANC was significantly associated with 23%, 31%, and 34% higher likelihood of providing MMF (AOR: 1.23; 95% CI: 1.05, 1.45; $p = 0.012$), MDD (AOR: 1.31; 95% CI: 1.13, 1.51; $p < 0.001$), and MAD (AOR: 1.34; 95% CI: 1.15, 1.56; $p < 0.001$) to their children, respectively, compared to mothers who did not receive ≥ 4 ANC.

Table 2: Multivariable regression models demonstrating the association between maternal utilization of the continuum of care and complementary feeding indicators.

	ISSSF			MMF			MDD			MAD		
Exposures	AOR α	95% CI	p-value	AOR α	95% CI	p-value	AOR α	95% CI	p-value	AOR α	95% CI	p-value
Full CoC												
No	Ref	-	-	Ref	-	-	Ref	-	-	Ref	-	-
Yes	1.30	0.77, 2.20	0.326	1.13	0.94, 1.37	0.202	1.29	1.10, 1.51	0.002	1.32	1.13, 1.55	0.001
≥ 4 ANC												
No	Ref	-	-	Ref	-	-	Ref	-	-	Ref	-	-
Yes	1.00	0.64, 1.57	0.984	1.23	1.05, 1.45	0.012	1.31	1.13, 1.51	0.000	1.34	1.15, 1.56	0.000
Delivery by SBA												
No	Ref	-	-	Ref	-	-	Ref	-	-	Ref	-	-
Yes	0.98	0.63, 1.52	0.919	0.94	0.80, 1.11	0.489	1.04	0.89, 1.22	0.621	1.03	0.87, 1.21	0.772
PNC within 48 hours												
No	Ref	-	-	Ref	-	-	Ref	-	-	Ref	-	-
Yes	1.27	0.83, 1.93	0.267	1.05	0.89, 1.24	0.545	0.99	0.85, 1.15	0.879	1.03	0.88, 1.20	0.720

^aAdjusted for Primary Sampling Unit (PSU), sampling strata, sampling weight, age at last delivery, education, husband's education, occupation, husband's occupation, parity, ever terminated pregnancy, desired pregnancy, wealth index, media exposure, accessing healthcare, religion, residence, division, survey round. ISSSF = Introduction to solid, semi-solid, and soft food, MMF = Minimum meal frequency, MDD = Minimum dietary diversity, MAD = Minimum acceptable diet.

In all regression models, the SE of the odds ratio was <2 and VIF was <3 , indicating the absence of collinearity among the independent variables. The detailed regression models are provided as the supplementary file ([Supplementary File 1](#)). There were some observations ($n=83$) with missing values in the independent variables in the analyzed sample. Therefore, we also conducted the analysis after excluding observations with missing values. However, we did not find any significant difference in the direction and significance of the association between analysis including observations with missing values in independent variables and complete case analysis.

Discussion

Our findings demonstrate significant effects of maternal utilization of CoC on MDD and MAD. Digging down the effect of CoC components, the status of receiving ≥ 4 ANC exhibited a significant positive associated with MMF, MDD, and MAD in Bangladesh. However, we did not find any significant effect of the status of maternal utilization of CoC or its components on ISSSF and MMF.

As we found, a previous study, conducted using the BDHS 2007 data, also identified no significant association between ISSSF and the number of ANC and PNC visits (26). Timely ISSSF is associated with exclusive breastfeeding because children who are not exclusively breastfed are likely

to receive family foods earlier than six months of age, which results in disqualifying to timely ISSSF. In Bangladesh, the exclusive breastfeeding rate decreased from 64% in 2017 to 53% in 2022; therefore, this might result in the statistically insignificant effect of maternal utilization of CoC and its components on timely ISSSF. There is a scarcity of studies explicitly examining the association between maternal CoC utilization and the timely ISSSF. Previous studies highlight that complementary feeding practices were primarily influenced by maternal knowledge, cultural beliefs, family practices, and household factors, rather than formal healthcare service utilization (13,27). Similarly, a study in rural Bangladesh revealed that only 19% of mothers knew the appropriate age for introducing complementary foods, and this knowledge was not significantly associated with their feeding practices (28). These provide an insight that although an increase in maternal CoC utilization indicates a better coverage of maternal healthcare services, it may not ensure better child feeding practices, e.g., ISSSF, unless the maternal healthcare services are fortified with targeted nutrition education and behavior change interventions.

The analysis revealed that mothers who received ≥ 4 ANC and full CoC had significantly higher odds of providing MMF. This finding is consistent with findings from a previous study conducted using Bangladesh Integrated Household Survey (BIHS), which reported a positive association between ≥ 4 ANC and MMF (29). Indeed, ANC provides platforms for counseling on nutrition as well as the importance of child feeding frequency and dietary adequacy. MAD is a composite indicator of both MMF and MDD. In this study, we found that the status of utilizing full CoC and receiving ≥ 4 ANC had significant positive association with MAD. Similar findings from the BIHS 2018–2019 and other South Asian countries also reported a positive association between ≥ 4 ANC visits and MAD (22,29–31). Four or more ANC visits facilitates positive complementary feeding practices such as MDD and MAD through sustained opportunities for nutritional counseling (32).

Mothers who received the full CoC package were 29% more likely to provide foods meeting the MDD for their children. Notably, the trend of MDD in Bangladesh remained relatively consistent over a ten-year period from 2004 to 2014 (14). Looking into the individual effects of components of CoC, status of receiving ≥ 4 ANC also exhibited a significant association with MDD status. Previous study identified that mothers who received ≥ 4 ANC visits were 31% more likely to give their babies minimum diversified foods than those who did not have any ANC visits at (33).

No significant effect of delivery by SBA and PNC within 48 hours of delivery was observed on MDD. This could be because these services are more focused on maternal and essential newborn care rather than care focusing on complementary feeding practices although a previous study reported significant associations between dietary diversity score and status of receiving ≥ 4 ANC,

which corresponds to our findings (34).

Concerning strengths of this study, the analysis is conducted based on two rounds of nationally representative surveys (BDHS 2017–18 and 2022), which were conducted after the National Nutrition Policy'2015 was adopted in Bangladesh. Therefore, findings provide a valuable insight about how the benefits of mainstreaming nutrition services to maternal and child healthcare platforms are reflected in complementary feeding practices. The exposure variables include both maternal utilization of CoC and its components, i.e. ≥ 4 ANC, delivery assisted by SBA, and PNC within 48 hours of delivery, which gives a holistic overview about their strengths of associations with key WHO-recommended complementary feeding practices and which maternal healthcare component should be galvanized with nutrition interventions to increase the benefits. Furthermore, adjustment of covariates increased the accuracy of the estimates. The surveys utilize validated measurements of the exposure and outcome, providing strengths to the internal validity. Apart from strengths, a few limitations are worth mentioning. The cross-sectional design limits causal inference between the utilization of maternal CoC and complementary feeding practices. Key behavioral factors such as maternal nutritional knowledge and attitude, cultural norms, household food security, and intra-household food dynamics were not estimated in the survey, and therefore not included in the analysis. Furthermore, the quality or content of ANC and PNC, especially nutrition counseling, was not taken into consideration while analyzing the data.

Findings can serve as a resource to policymakers in Bangladesh in several ways. The decrease in exclusive breastfeeding (from 64% to 53% during 2017-2022) and the insignificant association between maternal utilization of CoC and timely ISSSF indicate the need for policy support and interventions, especially to improve exclusive breastfeeding in Bangladesh, so that the benefits of maternal CoC are translated to timely ISSSF. Although the status of receiving ≥ 4 ANC appears to significantly contribute to better MMF, MDD and MAD, there was variance in direction, magnitude and significance of associations for other exposures, i.e. delivery assisted by SBA and receiving PNC within 48 hours of delivery. This indicates the whole package of maternal healthcare services is not received by a big proportion of mothers, indicating high dropout from maternal utilization of CoC. Therefore, the findings indicate the need for reducing dropout from maternal utilization of CoC to better reflect its benefits on complementary feeding practices.

Conclusion

Maternal utilization of CoC, especially through receiving ≥ 4 ANC, in Bangladesh appears to significantly contribute to MDD and MAD among children 6-23 months of age. Policy supports and interventions should be put in place to reflect the benefits of CoC on timely ISSSF and MMF.

Competing interest

No competing interest is declared.

Authors' contributions

MAR: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing- Original draft, Writing- Review and editing, Visualization, Supervision, Project administration; **RI:** Software, Validation, Investigation, Data curation, Writing- Original draft, Writing- Review and editing, Visualization; **RBD:** Software, Validation, Investigation, Data curation, Writing- Original draft, Writing- Review and editing, Visualization; **JB:** Software, Validation, Investigation, Data curation, Writing- Original draft, Writing- Review and editing, Visualization; **PS:** Investigation, Writing- Original draft, Writing- Review and editing, Visualization; **MRA:** Writing- Review and editing, Supervision, Visualization; **SS:** Writing- Review and editing, Supervision, Visualization.

Data availability statement

Publicly accessible Bangladesh Demographic and Health (BDHS) data was used in this study. The data can be accessed either at <https://dhsprogram.com/> or upon reasonable request to the corresponding author. The full statistical models are presented as the supplementary file ([Supplementary file](#)).

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List of abbreviations

ANC (Antenatal Care)
BDHS (Bangladesh Demographic and Health Survey)
CoC (Continuum of Care)
ISSSF (Introduction to Solid, Semi-solid and Soft Food)
MAD (Minimum Acceptable Diet)
MMF (Minimum Meal Frequency)
MDD (Minimum Dietary Diversity)
PNC (Postnatal Care)

SBA (Skilled Birth Attendant)

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Supplementary Files

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