

Association between exclusive breastfeeding and maternal underweight during the first six months postpartum in Bangladesh: a cross-sectional propensity-score full-matching analysis

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Abstract

Background

Maternal underweight remains a concern during the postpartum period in Bangladesh. This study examined the cross-sectional adjusted prevalence association between exclusive breastfeeding and maternal underweight among mothers of infants younger than six months.

Methods

We analysed the 2022 Bangladesh Demographic and Health Survey. The original complete-case sample included 423 nonpregnant, ever-married mothers whose most recent infant was aged 0–5 completed months, alive, living with the mother, and currently breastfeeding. Maternal underweight was defined as body mass index $< 18.5 \text{ kg/m}^2$. The primary analysis targeted the average treatment effect among eligible mothers within the common propensity-score support. Sampling-weighted propensity scores were used for full matching, with exact matching on completed infant age. A survey-weighted modified Poisson model adjusted for completed infant age and maternal age estimated the prevalence ratio; marginal standardization estimated adjusted prevalences and their difference.

Results

Exclusive breastfeeding was reported by 243 of 423 mothers, with a survey-weighted prevalence of 58.0% (95% CI 52.7%–63.1%). Maternal underweight occurred in 39 mothers, corresponding to 8.8% (95% CI 6.4%–12.1%). The common-support matched sample included 409 mothers and 36 underweight cases. Exclusive breastfeeding was associated with an adjusted prevalence ratio of 1.29 (95% CI 0.55–3.04; $p = 0.552$). Standardized underweight prevalence was 7.42% under non-exclusive breastfeeding and 9.60% under exclusive breastfeeding, a difference of 2.18 percentage points (95% CI -4.67 to 9.04; $p = 0.532$).

Conclusion

The estimate was compatible with both a lower and a higher prevalence of maternal underweight, and the confidence interval was wide. Because breastfeeding status and maternal body mass index were measured at the same survey visit, temporality and causality cannot be established. Further longitudinal assessment of maternal nutrition during lactation is warranted without weakening recommended breastfeeding support.

1 Introduction

Maternal underweight, commonly defined as body mass index (BMI) below 18.5 kg/m², remains an indicator of chronic energy deficiency among women of reproductive age (1, 2). Although overweight and obesity are increasing in many low- and middle-income countries, underweight continues to affect socioeconomically disadvantaged women and contributes to the double burden of malnutrition (3, 4). In Bangladesh, approximately 12 of every 100 women aged 15–49 years are classified as underweight (5). The early postpartum period combines recovery from pregnancy and childbirth with infant feeding, childcare, household work, and, for some women, paid employment. Lactation increases maternal energy requirements, but its nutritional consequences depend on pre-pregnancy nutritional status, gestational weight gain, dietary intake, food security, morbidity, workload, and access to support (6–8). Bangladesh-specific studies have linked pregnancy and lactation with postpartum weight change and have documented inadequate nutrient intake among some lactating women (7–10). These findings indicate maternal nutritional vulnerability but do not establish that breastfeeding causes underweight.

The World Health Organization and UNICEF recommend exclusive breastfeeding for the first six months of life (11, 12). Under the standard indicator, an exclusively breastfed infant receives breast milk only, apart from oral rehydration solution, vitamin or mineral supplements, and medicines (11). Mothers classified as not exclusively breastfeeding may nevertheless breastfeed frequently; the indicator does not measure breastfeeding frequency, milk transfer, or maternal energy expenditure. Evidence on breastfeeding and postpartum weight change is heterogeneous, and maternal diet and social conditions may shape observed associations (13–16).

An unadjusted comparison is difficult to interpret because exclusive breastfeeding is not randomly distributed. Infant age, maternal age, parity, education, household wealth, geographic location, antenatal care, and delivery mode may be associated with feeding practices and maternal nutritional status. Propensity-score methods can improve measured comparability, but they cannot establish temporal order, remove unmeasured confounding, or determine whether maternal underweight preceded the observed breastfeeding pattern. The objective of this cross-sectional study was to estimate the adjusted prevalence association between exclusive breastfeeding and maternal underweight among nonpregnant, ever-married Bangladeshi mothers whose most recent infant was aged 0–5 completed months, alive, living with the mother, and currently breastfeeding. The primary estimand was the average treatment effect among eligible mothers within common propensity-score support. Relative and absolute adjusted prevalence measures were estimated, and sensitivity analyses evaluated alternative estimands, weighting approaches, and outcome-model specifications.

2 Materials and methods

2.1 Study design and population

This was a cross-sectional secondary analysis of the 2022 Bangladesh Demographic and Health Survey (BDHS), a nationally representative household survey with a two-stage stratified sampling design. In the first stage, 674 enumeration areas were selected, followed by systematic selection of households. The

long woman's questionnaire was administered in a subsample, and one-half of those households were selected for biomarker measurements, including maternal height and weight (5). The analysis used the Children's Recode file (BDKR81FL.DTA). The de-identified BDKR81FL.DTA file was accessed for research purposes on 27 November 2026. The authors had no access to information that could identify individual participants during or after the original data collection. The available participant audit identified 8,784 source records, 934 records for infants aged 0–5 completed months, and 873 mothers eligible before missing-data exclusions. The complete-case sample included 423 mothers after excluding 430 records with missing or invalid maternal BMI and 20 with missing analysis covariates; no records were excluded for missing survey-design information. The audit also recorded 54 exclusions for not currently breastfeeding, 6 for not representing the most recent birth, 1 for the infant not living with the mother, and none for infant death, current pregnancy, or anthropometric ineligibility. The participant-selection process is presented in Fig. 1.

2.2 Outcome definition

The outcome variable was maternal underweight, categorized as “Yes” or “No.” Maternal height and weight were measured by trained survey personnel using standardized equipment and procedures described in the 2022 BDHS report (1). Body mass index (BMI) was obtained from the DHS-derived variable v445 after division by 100. As a data-quality check, the derived BMI values were compared with BMI recalculated from measured weight (v437) and height (v438) (5, 17).

Maternal underweight was defined as a BMI < 18.5 kg/m² and coded as “Yes.” Women with a BMI ≥ 18.5 kg/m² were classified as not underweight and coded as “No,” in accordance with the World Health Organization classification for adults (1, 2).

Anthropometric measurements were collected only from women selected for the designated biomarker subsample. Variables indicating eligibility for anthropometric assessment and the corresponding measurement outcomes were retained to distinguish planned non-measurement from item nonresponse.

2.3 Exposure definition

The exposure was exclusive breastfeeding during the day and night preceding the survey. Infants who were currently breastfed and had received only breast milk during the preceding 24 hours were classified as exclusively breastfed; oral rehydration solution, vitamin or mineral supplements, and medicines were permitted. Infants who received water, other liquids, formula, other milk, or solid, semi-solid, or soft foods were classified as not exclusively breastfed (11, 17). All 423 mothers in the sample were currently breastfeeding. Consequently, the non-exclusive group consisted entirely of currently breastfeeding mothers whose infants received at least one non-permitted liquid or food.

2.4 Covariates and conceptual rationale

Covariates were prespecified as measured characteristics plausibly related to both feeding practices and maternal nutritional status. Completed infant age represents time since delivery and the age-related decline in exclusive breastfeeding. Maternal age and parity reflect reproductive history and nutritional reserves. Education and household wealth may influence feeding knowledge, diet, and access to care. Administrative division captures geographic heterogeneity; antenatal-care use reflects maternal healthcare contact; and delivery mode may influence early feeding and postpartum recovery. The propensity-score model included completed infant age, maternal age, parity, maternal education, household wealth quintile, administrative division, antenatal-care visits, and delivery mode. These variables were retained irrespective of univariable *p-values* (18) .

Completed infant age was coded categorically as 0, 1, 2, 3, 4, or 5 months. Maternal age was categorized as 15–24, 25–34, and ≥ 35 years. Parity was categorized as 1, 2–3, and ≥ 4 births. Maternal education was categorized as no education, primary, secondary, and higher secondary or above. Household wealth was represented by the five BDHS wealth quintiles; division by the eight administrative divisions; antenatal care as < 4 or ≥ 4 visits; and delivery mode as caesarean or vaginal. Residence, employment, birth interval, dietary intake, household food security, pre-pregnancy BMI, gestational weight gain, maternal morbidity, workload, and breastfeeding intensity were not included because they were unavailable in the final analysis dataset, were not validated for the prespecified reconstruction, or were not measured in a form suitable for this analysis. Residual confounding from these factors remains possible.

2.5 Survey design and descriptive analysis

Descriptive analyses used the variables PSU, sample strata, and sampling weight. The sampling weight was derived from the BDHS women's weight variable v005 and was used in all survey analyses and as the sampling-weight argument in propensity-score matching. The survey design used primary sampling units nested within strata. Strata containing a single primary sampling unit were handled with options (survey.lonely.psu = "adjust"). Categorical variables were summarized with unweighted n/N and survey-weighted percentages with 95% confidence intervals. The survey-weighted prevalence of maternal underweight was estimated overall and within exclusive-breastfeeding groups. Rao-Scott tests were used only for descriptive comparisons. Statistical inference emphasized estimates and 95% confidence intervals; two-sided $p < 0.05$ was the prespecified significance threshold.

2.6 Propensity-score estimation, common support, and full matching

The primary estimand was the average treatment effect (ATE) among eligible complete-case mothers within the common propensity-score support. An initial sampling-weighted logistic regression estimated each mother's probability of exclusive breastfeeding from completed infant age, maternal age, parity, education, wealth quintile, division, antenatal-care visits, and delivery mode. The common-support interval was defined as the intersection of the exposure-group propensity-score ranges (0.0705–0.9283). Fourteen observations outside this interval were excluded, leaving 409 mothers.

The propensity score was re-estimated in the support-restricted sample through MatchIt using method = "full", distance = "glm", link = "logit", estimand = "ATE", exact = ~ infant_age_month, discard = "none", reestimate = FALSE, and s.weights = Sampling_weight. No caliper was used and no additional optimizer settings were specified. Exact matching required each full-matching subclass to contain mothers within the same completed infant-age month. The matched dataset was extracted with include.s.weights = TRUE; therefore, the resulting weights variable already represented the product of the full-matching and DHS sampling weights and was not multiplied by Sampling weight a second time.

2.7 Balance and weight diagnostics

Covariate balance was evaluated with absolute standardized mean differences (SMDs) before and after matching presented in Fig. 2. An absolute SMD < 0.10 was considered acceptable for measured covariate terms. Month-specific indicators were assessed for completed infant age. After matching, all measured covariate terms had absolute SMDs <= 0.0564; the propensity-score distance retained an absolute SMD of 0.1502 and was reported separately rather than treated as a covariate-level balance success. The effective sample sizes were 90.66 in the non-exclusive group and 129.59 in the exclusive group. Combined weights ranged from 0.0451 to 7.2930; the median was 0.7672 and the 99th percentile was 5.4650.

2.8 Primary outcome model

The primary association was estimated with survey-weighted modified Poisson regression using svyglm(..., family = quasipoisson(link = "log")). The outcome was maternal underweight and the predictors were exclusive breastfeeding, completed infant age as a categorical variable, and maternal age category. This reduced adjustment set was prespecified after matching to avoid the instability of fitting the full 27-coefficient outcome model with only 36 underweight cases in the matched sample. The quasipoisson specification provided the log-mean model for prevalence-ratio estimation; design-based standard errors were obtained from the survey design rather than from a conventional Poisson count variance assumption (19–22).

The exclusive-breastfeeding coefficient was exponentiated to obtain the adjusted prevalence ratio. 95% confidence intervals were calculated with confint() for the fitted survey model, and p-values were taken from the survey-model coefficient table. The matched survey design had 290 design degrees of freedom. The primary model included nine coefficients and converged without warnings recorded in the verified output.

2.9 Marginal standardization

For the primary ATE analysis, two prediction datasets were created from the 409 matched mothers. Exclusive breastfeeding was set to no for every mother in one dataset and yes for every mother in the other, while observed covariates were retained. Predictions were averaged using the final combined sampling and matching weights. These standardized estimates therefore refer to the weighted covariate distribution of eligible mothers within the common-support region under the ATE weighting scheme. The

prevalence difference was calculated as exclusive minus non-exclusive breastfeeding. Standard errors and 95% confidence intervals were obtained from the survey-model covariance matrix using the delta method (23–25).

Modified Poisson predictions were checked under both standardized exposure scenarios. In the primary model, predictions ranged from 0.0043 to 0.1411 when all mothers were set to non-exclusive breastfeeding and from 0.0056 to 0.1827 when all were set to exclusive breastfeeding. No prediction was below 0, above 1, or non-finite; therefore, the standardized prevalences and prevalence difference from the primary model were retained.

2.10 Sensitivity analyses

Sensitivity analyses included: truncating final combined weights at the 1st and 99th percentiles; ATT full matching; an unmatched survey-weighted modified Poisson model; an exposure-only matched model; the fully adjusted matched model; and overlap weighting. The comparator-restricted analysis was not fitted separately because all 423 mothers were currently breastfeeding and the restriction would reproduce the primary comparison. A three-category feeding analysis was not estimable because no mother was classified as not currently breastfeeding. The fully adjusted matched model contained 27 coefficients and produced two fitted values above 1 under the all-exclusive scenario, with a maximum of 1.3351. Its prevalence ratio was retained as a sensitivity estimate, but its marginal prevalences and prevalence difference were removed from both the main manuscript and S4 Table because the standardized predictions were outside the valid probability range.

2.11 Missing data, software, ethics, and reporting

A complete-case approach was used. No imputation was performed for missing exposure, outcome, covariate, or survey-design information. Women structurally outside the anthropometry subsample were distinguished conceptually from item nonresponse. Because exclusions may have selected a nutritionally or socioeconomically different sample, selection bias cannot be excluded. The verified analyses were run in R 4.3.0 using survey 4.2-1, MatchIt 4.5.5, cobalt 4.6.3, WeightIt 1.4.0, and supporting tidyverse packages. The 2022 BDHS protocol received ethical approval from the ICF Institutional Review Board and the Bangladesh Medical Research Council, and informed consent was obtained in the original survey. The present study used de-identified secondary data obtained after authorization from The DHS Program. The study was reported with reference to the STROBE recommendations for cross-sectional studies (26).

3 Results

3.1 Original sample

The original complete-case sample comprised 423 mothers: 243 were exclusively breastfeeding and 180 were currently breastfeeding but not exclusively breastfeeding. No mother was classified as not currently breastfeeding. The survey-weighted prevalence of exclusive breastfeeding was 58.0% (95% CI

52.7%-63.1%), and maternal underweight was observed in 39 of 423 mothers, corresponding to 8.8% (95% CI 6.4%-12.1%).

The unadjusted survey-weighted prevalence of maternal underweight was 6.5% (95% CI 3.6%-11.5%; 13/180) among mothers who were not exclusively breastfeeding and 10.5% (95% CI 7.0%-15.5%; 26/243) among mothers who were exclusively breastfeeding. Table 1 presents the descriptive characteristics.

Table 1
Characteristics of the original complete-case sample.

Variable	Category	Unweighted n/N	Survey-weighted percentage (95% CI)
Infant age	0 completed months	72/423	17.1% (13.6%-21.2%)
	1 completed month	83/423	19.1% (15.2%-23.8%)
	2 completed months	65/423	15.6% (11.9%-20.1%)
	3 completed months	75/423	17.3% (13.8%-21.3%)
	4 completed months	62/423	14.4% (11.0%-18.5%)
	5 completed months	66/423	16.6% (12.7%-21.5%)
Maternal age	15–24 years	235/423	55.8% (50.6%-60.8%)
	25–34 years	165/423	38.9% (34.1%-43.9%)
	>=35 years	23/423	5.3% (3.4%-8.1%)
Parity	1 birth	172/423	39.8% (34.5%-45.3%)
	2–3 births	216/423	51.6% (46.1%-57.1%)
	>=4 births	35/423	8.6% (6.0%-12.2%)
Maternal education	No education	17/423	4.7% (2.9%-7.6%)
	Primary	83/423	17.9% (14.1%-22.3%)
	Secondary	222/423	53.9% (48.3%-59.4%)
	Higher secondary or above	101/423	23.5% (19.1%-28.6%)
Household wealth quintile	Poorest	73/423	16.8% (13.4%-20.7%)
	Poorer	86/423	20.0% (16.4%-24.2%)
	Middle	90/423	23.3% (18.8%-28.5%)
	Richer	91/423	20.2% (16.1%-25.0%)
	Richest	83/423	19.7% (15.7%-24.5%)
Administrative division	Barishal	52/423	7.0% (5.9%-8.3%)
	Chattogram	75/423	22.3% (19.5%-25.4%)
	Dhaka	67/423	25.5% (22.7%-28.5%)
	Khulna	48/423	10.6% (9.0%-12.5%)
	Mymensingh	55/423	8.8% (7.5%-10.3%)

Variable	Category	Unweighted n/N	Survey-weighted percentage (95% CI)
	Rajshahi	46/423	11.5% (10.0%-13.1%)
	Rangpur	36/423	8.3% (7.2%-9.6%)
	Sylhet	44/423	5.9% (5.0%-6.9%)
Antenatal-care visits	< 4	243/423	60.3% (54.6%-65.7%)
	>=4	180/423	39.7% (34.3%-45.4%)
Delivery mode	Caesarean	211/423	50.0% (44.9%-55.2%)
	Vaginal	212/423	50.0% (44.8%-55.1%)
Exclusive breastfeeding	No	180/423	42.0% (36.9%-47.3%)
	Yes	243/423	58.0% (52.7%-63.1%)
Maternal underweight	No	384/423	91.2% (87.9%-93.6%)
	Yes	39/423	8.8% (6.4%-12.1%)

3.2 Common support, matching, and balance

The common-support restriction retained 409 of 423 mothers and excluded 14 observations outside the propensity-score interval 0.0705–0.9283 (shown in Table 2). The matched sample included 173 non-exclusive and 236 exclusive breastfeeding mothers. Exact matching on completed infant age retained both exposure groups within each of the six age strata. All measured covariate terms had post-matching absolute SMDs ≤ 0.0564 ; the propensity-score distance had an SMD of 0.1502. The combined-weight effective sample sizes were 90.66 and 129.59, respectively.

Table 2
Common-support, balance, and weight diagnostics for the primary ATE analysis.

Diagnostic	Value
Original complete-case sample	423
Common-support matched sample	409
Excluded outside common support	14
Common-support limits	0.0705–0.9283
Non-exclusive / exclusive mothers	173 / 236
Underweight cases: non-exclusive / exclusive	11 / 25
ESS: non-exclusive / exclusive	90.66 / 129.59
Combined weight: minimum / median / 99th percentile / maximum	0.0451 / 0.7672 / 5.4650 / 7.2930
Maximum absolute SMD among measured covariate terms	0.0564
Absolute SMD for propensity-score distance	0.1502

3.3 Primary adjusted prevalence association

Table 3 presents the primary and sensitivity prevalence-ratio estimates. The primary reduced-adjustment model included 409 mothers and 36 underweight cases. Exclusive breastfeeding was associated with a prevalence ratio of 1.2944 (95% CI 0.5513–3.0395; $p = 0.552$) relative to non-exclusive breastfeeding. The confidence interval included 1 and was compatible with a substantial decrease or increase in prevalence.

Table 3
Primary and sensitivity prevalence-ratio estimates.

Analysis	Estimand	Target population	PR	95% CI	p-value
Primary reduced-adjustment ATE full matching	ATE	Eligible mothers within common support	1.2944	0.5513–3.0395	0.552
Fully adjusted matched model	ATE	Eligible mothers within common support	1.8292	0.9057–3.6940	0.092
1st/99th percentile weight-truncated model	ATE	Same common-support population	1.2885	0.5522–3.0068	0.556
ATT full matching	ATT	Exclusively breastfeeding mothers within common support	1.2591	0.5002–3.1698	0.624
Unmatched survey-weighted model	Adjusted population association	Original complete-case sample	1.7500	0.8704–3.5183	0.116
Exposure-only matched model	ATE	Eligible mothers within common support	1.2498	0.5340–2.9251	0.606
Overlap-weighted model	ATO	Propensity-score overlap population	1.6684	0.7577–3.6740	0.203

Note: The primary and matched sensitivity analyses used 409 mothers with 36 underweight cases; the unmatched and overlap-weighted analyses used the original 423 mothers with 39 cases. Non-exclusive breastfeeding was the reference group. The primary estimand was the ATE among eligible mothers within common support. Matched analyses used final weights extracted after matching with DHS sampling weights incorporated; the unmatched model used the DHS sampling weight only, and the overlap analysis used final sampling-weighted overlap weights. The primary model adjusted for completed infant age and maternal age; the fully adjusted model included all prespecified covariates; and the exposure-only model included only exclusive breastfeeding. Confidence intervals and p-values used survey-design-based covariance; matched models had 290 design degrees of freedom.

3.4 Marginally standardized prevalences

Under the primary ATE model (displayed in Table 4), the standardized prevalence of maternal underweight was 7.42% when all matched mothers were set to non-exclusive breastfeeding and 9.60% when all were set to exclusive breastfeeding. The adjusted prevalence difference was 2.18 percentage points (95% CI -4.67 to 9.04; $p = 0.532$).

Table 4
Marginally standardized maternal-underweight prevalence and prevalence difference in the primary analysis.

Scenario / contrast	Estimate	95% CI	p-value
All mothers set to non-exclusive breastfeeding	7.42%	—	-
All mothers set to exclusive breastfeeding	9.60%	—	-
Exclusive minus non-exclusive	2.18 percentage points	-4.67 to 9.04	0.532
Note: The primary analysis included 409 mothers and 36 underweight cases and targeted the ATE among eligible mothers within common support. Final analysis weights incorporated the DHS sampling weight and ATE full-matching weights. Standardization used the weighted covariate distribution of the matched sample, with non-exclusive breastfeeding as the reference condition. The model adjusted for completed infant age and maternal age. The prevalence-difference confidence interval and p-value used the survey-design-based covariance matrix and delta method. Separate confidence intervals for the two standardized prevalences were not available in the verified output and are therefore not reported; the unresolved placeholder cells were removed.			

3.5 Prediction validity and sensitivity analyses

Table 5 ensures that all the primary-model standardized predictions were within 0 and 1. In contrast, the fully adjusted matched model generated two predictions above 1 under the all-exclusive scenario, with a maximum of 1.3351. Accordingly, only the prevalence ratio from the fully adjusted model was retained; its marginal prevalences and prevalence difference were removed from the main results and S4 Table.

Table 5
Prediction validity for the primary modified Poisson model.

Standardized scenario	Minimum	Maximum	Below 0	Above 1	Non-finite
All set to non-exclusive breastfeeding	0.0043	0.1411	0	0	0
All set to exclusive breastfeeding	0.0056	0.1827	0	0	0
Note: Prediction diagnostics are based on the primary ATE common-support model with 409 mothers and 36 underweight cases. Final weights incorporated DHS sampling and full-matching weights. Predictions were generated for the weighted matched-sample covariate distribution under all-non-exclusive and all-exclusive scenarios; the model adjusted for completed infant age and maternal age. Reference-group and inferential variance entries are not applicable to these range diagnostics.					

Sensitivity estimates were directionally above 1 but imprecise. The weight-truncated ATE model produced PR 1.2885 (95% CI 0.5522–3.0068), the ATT model PR 1.2591 (0.5002–3.1698), the unmatched model PR 1.7500 (0.8704–3.5183), the exposure-only matched model PR 1.2498 (0.5340–2.9251), and the overlap-weighted model PR 1.6684 (0.7577–3.6740). All corresponding confidence intervals included 1.

4 Discussion

4.1 Principal findings

In this cross-sectional analysis of Bangladeshi mothers during the first six months postpartum, the original sample had a survey-weighted maternal-underweight prevalence of 8.8%. After restriction to common propensity-score support, exact matching on completed infant age, and reduced survey-weighted outcome adjustment, the estimated prevalence ratio for exclusive versus non-exclusive breastfeeding was 1.29, with a wide 95% confidence interval from 0.55 to 3.04. The standardized prevalence difference was 2.18 percentage points, with a confidence interval from – 4.67 to 9.04. These estimates do not provide precise evidence of a difference in maternal-underweight prevalence.

Reverse causation is a central explanation for the observed pattern. Maternal underweight may have been present before pregnancy or before the current feeding pattern was established, and pre-existing maternal nutritional status could influence breastfeeding initiation, continuation, supplementation, or healthcare advice. Because BMI and feeding status were measured at the same visit, the analysis cannot determine whether breastfeeding preceded maternal underweight or the reverse. Propensity-score adjustment does not resolve this temporal ambiguity.

A nutritional-demand mechanism remains biologically plausible but hypothetical. Lactation increases energy requirements, and inadequate dietary intake could contribute to loss of maternal reserves in nutritionally vulnerable settings (6–10). However, all mothers in this study were currently breastfeeding, and the exposure contrast concerned exclusive versus non-exclusive feeding rather than breastfeeding versus no breastfeeding. The data did not measure breastfeeding frequency, milk transfer, maternal energy intake, gestational weight gain, or pre-pregnancy BMI. The study therefore cannot attribute the observed prevalence association to lactational energy expenditure.

The corrected analysis materially changed the interpretation of the original manuscript. The earlier, statistically significant estimates were based on a different matching and outcome-model specification. Under the verified ATE common-support analysis, the point estimate was smaller and the confidence interval included the null. Sensitivity analyses using alternative weights, estimands, and outcome-model specifications remained imprecise. This pattern supports cautious interpretation of direction and magnitude rather than a claim of robustness or statistical significance.

4.2 Methodological interpretation

The common-support restriction and exact infant-age matching addressed the strongest initial source of separation. Measured covariate terms achieved good balance, but the propensity-score distance remained above the prespecified 0.10 threshold. Weight variability also reduced effective sample size. The 1st/99th percentile truncation improved the maximum balance diagnostic and produced an estimate close to the primary result. Overlap weighting yielded stable weights and excellent balance for

the overlap population, but its target differs from the ATE common-support population. These diagnostics indicate that the comparison remains sensitive to overlap and weighting choices.

The primary reduced outcome model was selected because only 36 underweight cases remained in the matched sample. It converged and produced valid standardized predictions. The fully adjusted model was retained only as a sensitivity analysis because it estimated 27 coefficients and generated predictions above 1. The comparison between reduced, exposure-only, and fully adjusted models shows that model specification influences the point estimate, although all estimates were imprecise.

4.3 Implications

The results should not be interpreted as a reason to discourage exclusive breastfeeding, which remains recommended for the first six months (11, 12). The findings instead identify a need for better longitudinal evidence on maternal nutritional trajectories during lactation. Maternal nutrition assessment may be considered alongside breastfeeding services as a service-planning implication, but this study did not test an intervention or establish that such integration improves outcomes.

4.4 Strengths and limitations

Strengths include recent nationally representative data, measured maternal anthropometry, a defined early-postpartum population, standard 24-hour feeding indicators, explicit ATE targeting, sampling-weight integration within matching, common-support restriction, exact matching on completed infant age, detailed balance and weight diagnostics, and presentation of relative and absolute association measures. The primary model was simplified in response to sparse outcomes, and its standardized predictions were checked for validity.

Several limitations remain. First, the cross-sectional design prevents temporal or causal interpretation. Second, a single 24-hour recall may misclassify usual exclusive breastfeeding. Third, pre-pregnancy BMI, gestational weight gain, diet, food insecurity, morbidity, workload, birth interval, employment, breastfeeding intensity, and postnatal nutrition support were unavailable or unvalidated, leaving substantial potential for residual confounding. Fourth, the support restriction reduced the target population, and the effective sample size was smaller than the nominal sample. Fifth, the primary matched sample included only 36 underweight cases, producing wide confidence intervals. Sixth, complete-case exclusions may have introduced selection bias because mothers with missing or invalid BMI or missing covariate information may have differed from those included in the analytic sample. This possibility could not be fully evaluated because a variable-specific missingness profile and an included-versus-excluded comparison were not available.

5 Conclusion

Among nonpregnant, ever-married Bangladeshi mothers whose most recent infant was aged 0–5 completed months, alive, living with the mother, and currently breastfeeding, exclusive breastfeeding had an adjusted prevalence ratio of 1.29 for maternal underweight in the ATE common-support analysis. The

wide confidence interval included both lower and higher prevalence, and the standardized prevalence difference was small and imprecise. The findings represent a cross-sectional adjusted prevalence association and do not establish that exclusive breastfeeding caused maternal underweight. Longitudinal studies beginning before or during pregnancy are needed to clarify temporal direction and identify maternal nutrition needs during lactation.

Declarations

Ethics approval and consent to participate

This study used de-identified secondary data from the 2022 Bangladesh Demographic and Health Survey (BDHS). The original survey protocol received ethical approval from the ICF Institutional Review Board and the Bangladesh Medical Research Council, and informed consent was obtained from participants during the original survey. The present secondary analysis was conducted in accordance with the ethical principles of the **Declaration of Helsinki** and applicable standards for research using de-identified human-participant data. The authors obtained authorization from The DHS Program to access and analyze the dataset.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

ATE, average treatment effect; ATT, average treatment effect in the treated; ATO, average treatment effect in the overlap population; BDHS, Bangladesh Demographic and Health Survey; BMI, body mass index; CI, confidence interval; DHS, Demographic and Health Survey; PR, prevalence ratio; SMD, standardized mean difference; WHO, World Health Organization.

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Author Contribution

MR contributed to data extraction, data analysis, and manuscript writing. KBG contributed to data curation, data analysis, and manuscript writing. MHC conceptualized the study and critically reviewed

and edited the manuscript. NMK conceptualized and supervised the study and finalized the manuscript. All authors reviewed and approved the final manuscript.

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Data availability

The data analysed in this study are from the 2022 Bangladesh Demographic and Health Survey Children's Recode file (BDKR81FL.DTA). Researchers may request access from The DHS Program by creating an account, submitting a project description, and obtaining approval for Bangladesh survey data. The authors are not permitted to redistribute the raw third-party data. Other researchers can obtain the data through the same application process.

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Figures

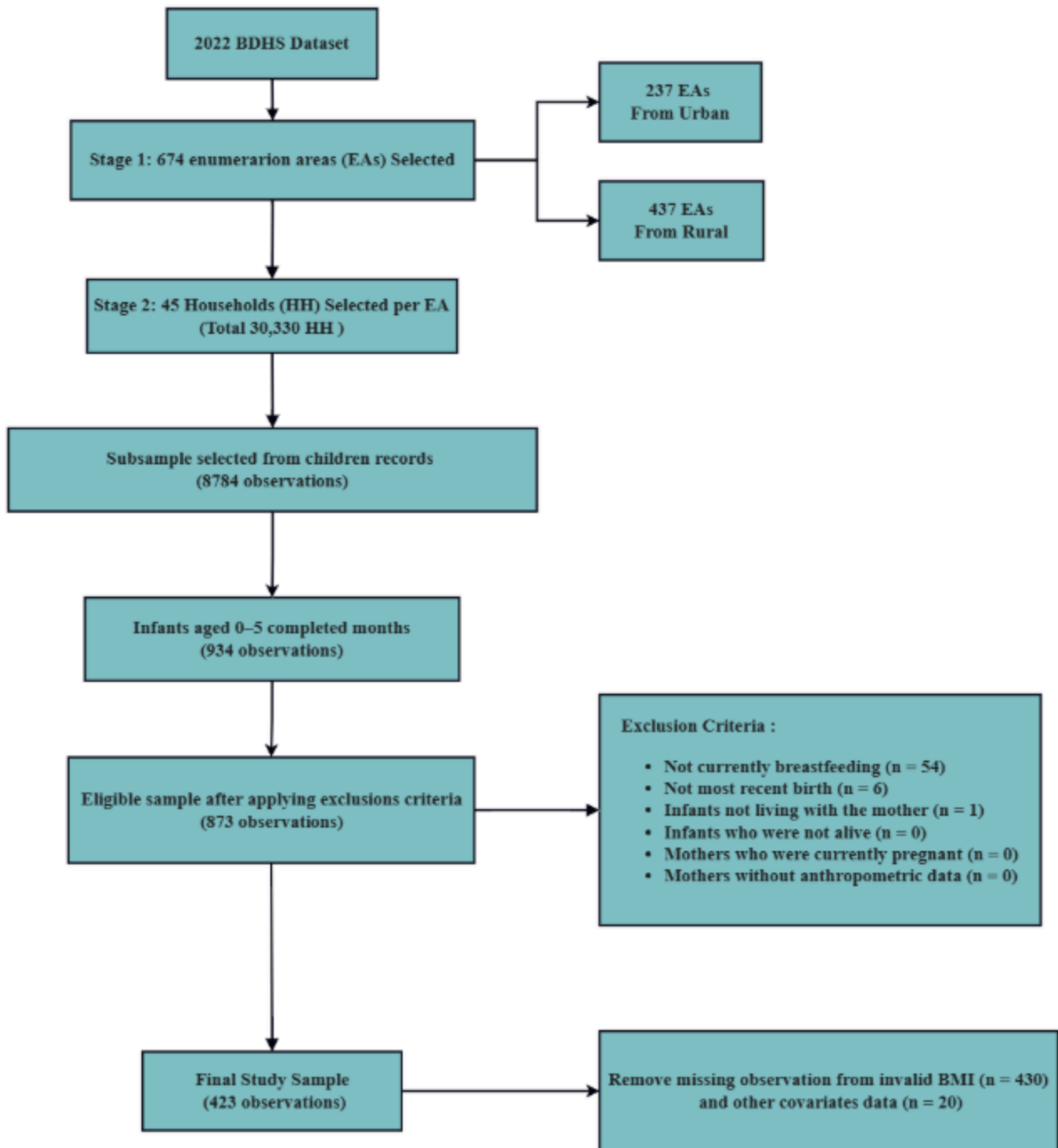


Figure 1

Participant flow for the original sample and the common-support matched primary sample.

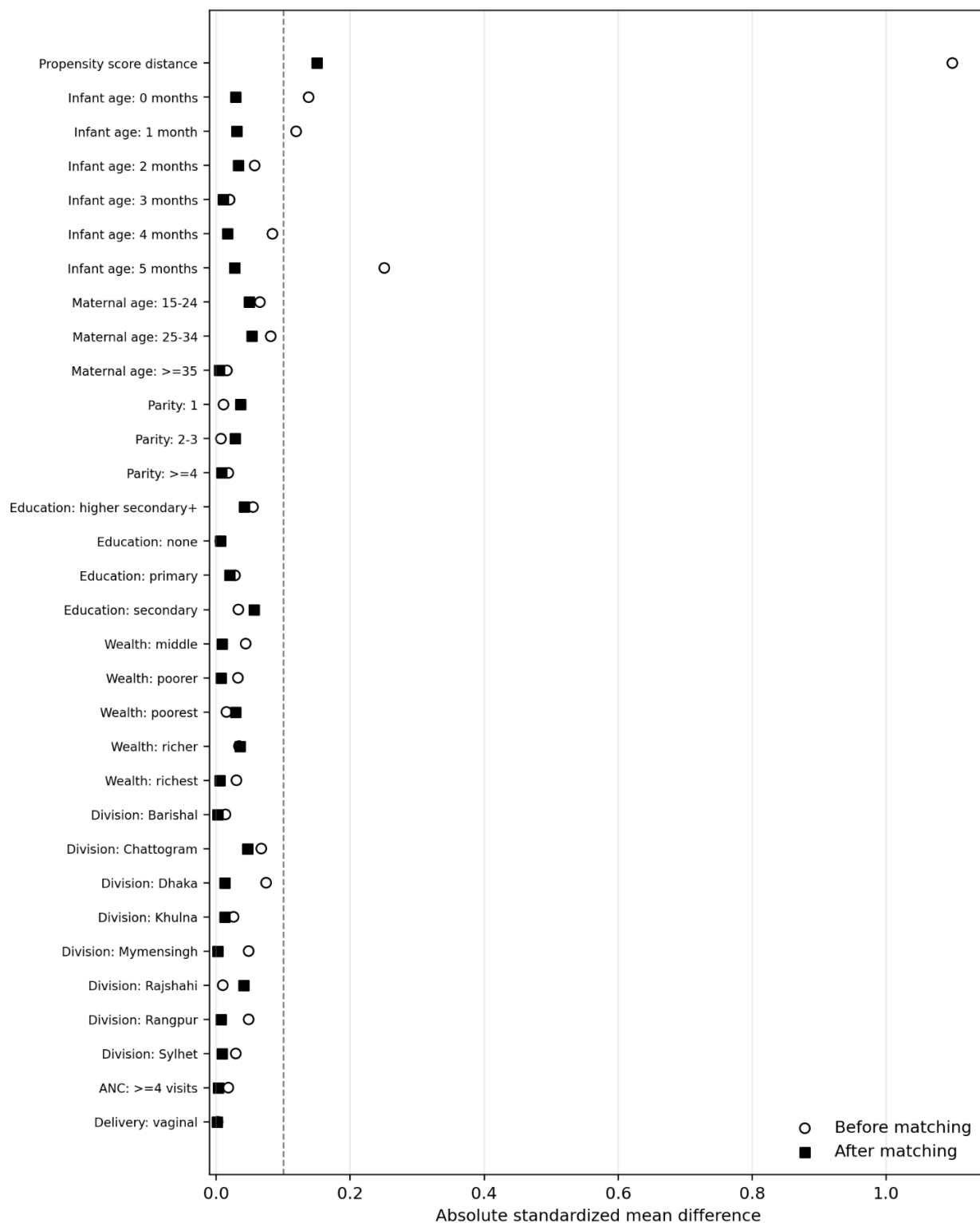


Figure 2

Absolute standardized mean differences before and after ATE full matching in the common-support sample. The dashed line marks 0.10. The propensity-score distance is displayed separately from the measured covariate terms and remained above 0.10 after matching.

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